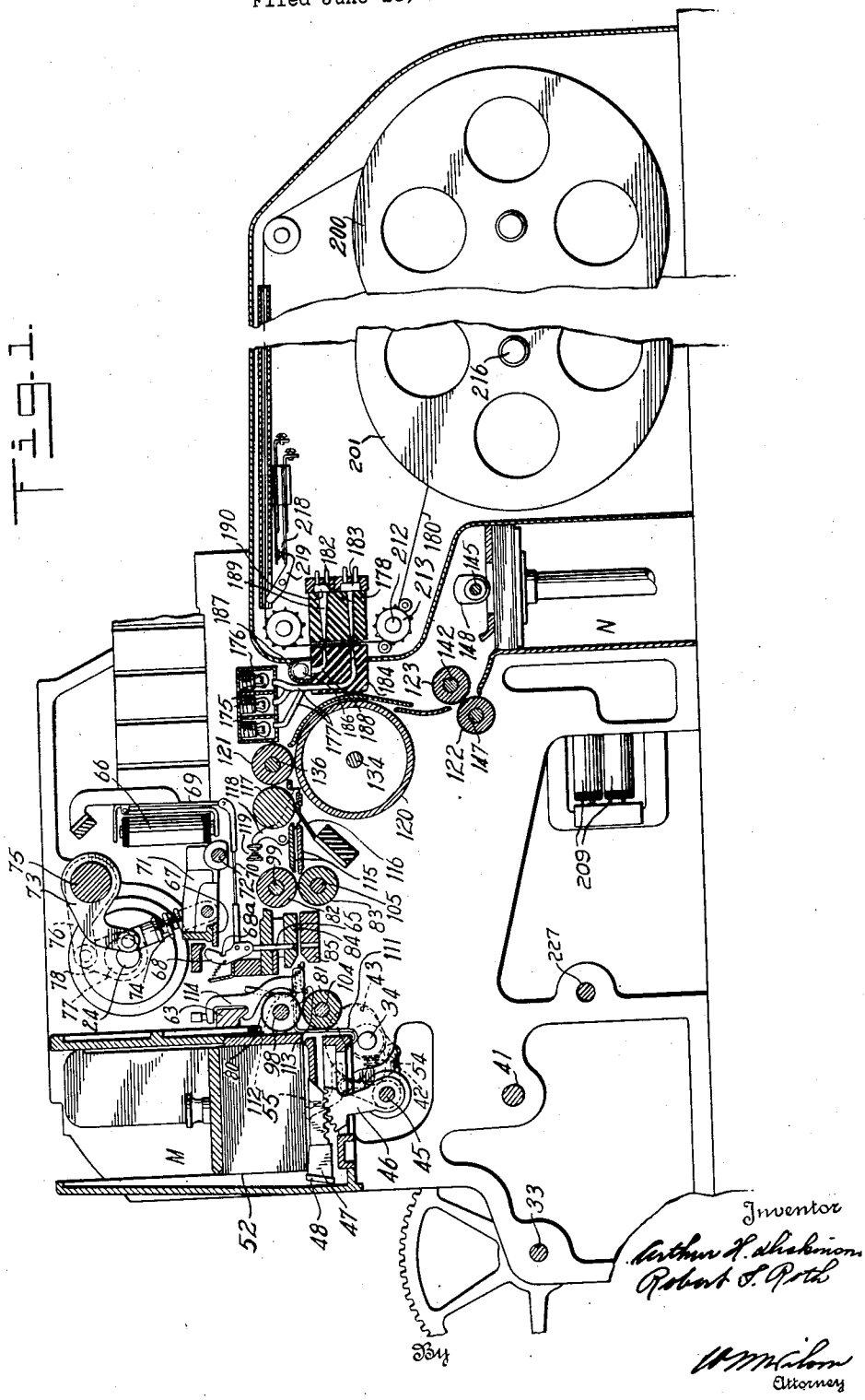
Dec. 10, 1940. A. H. DICKINSON ET AL 2,224,764

DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 1

Fig. 1.



Dec. 10, 1940. A. H. DICKINSON ET AL 2,224,764

DATA REPRODUCING MACHINE

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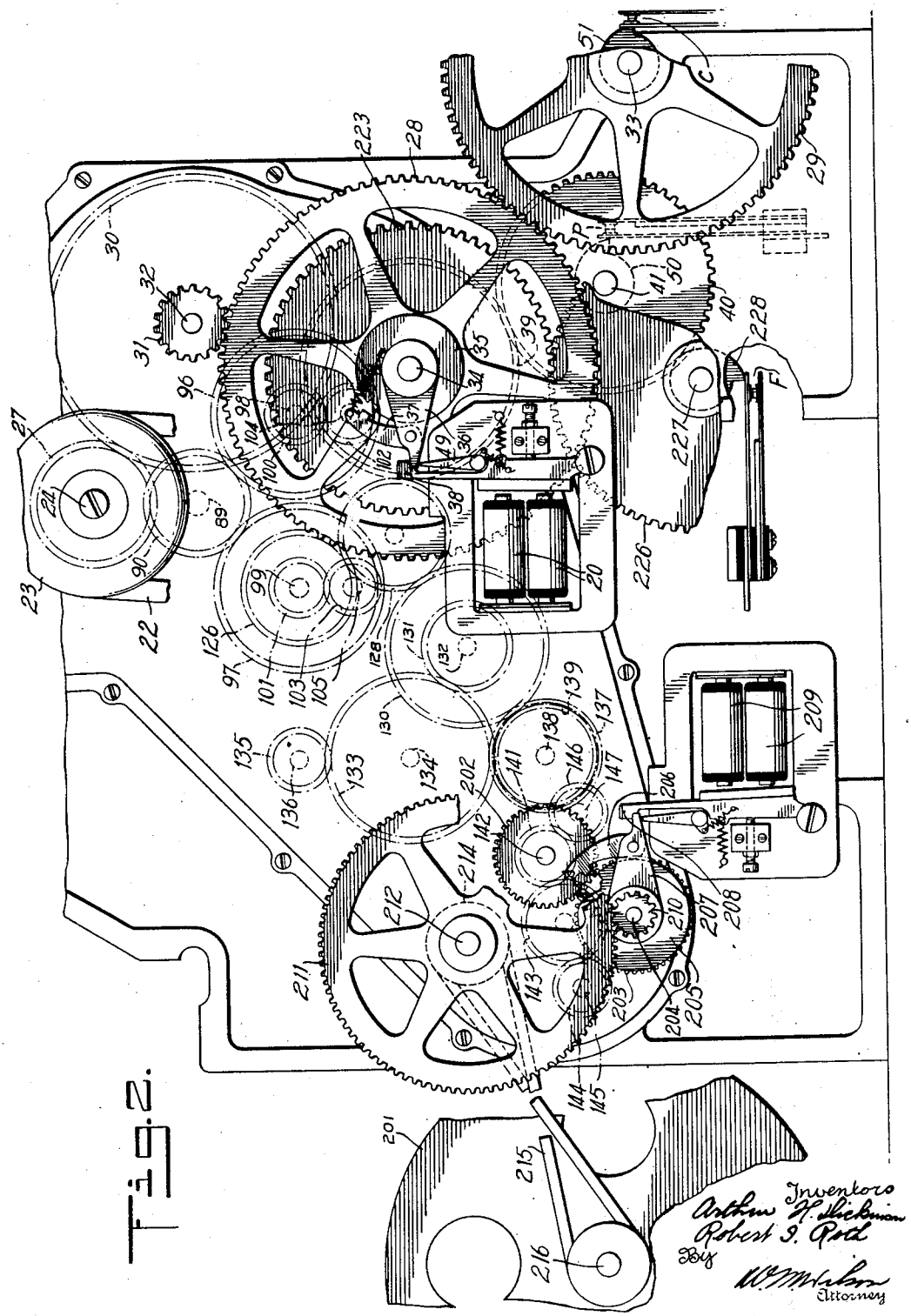

Fig. 2.

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DATA REPRODUCING MACHINE

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Fig. 3.

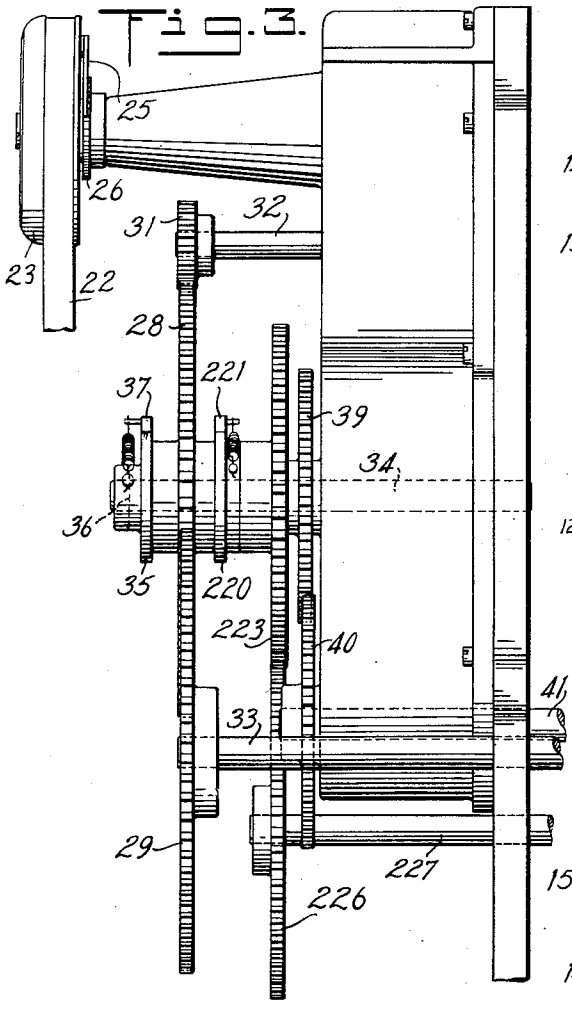
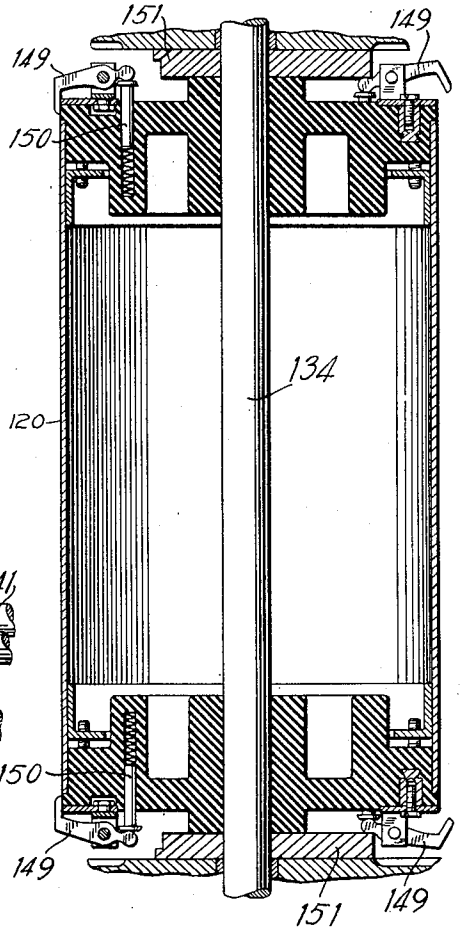


Fig. 8.



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DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 4

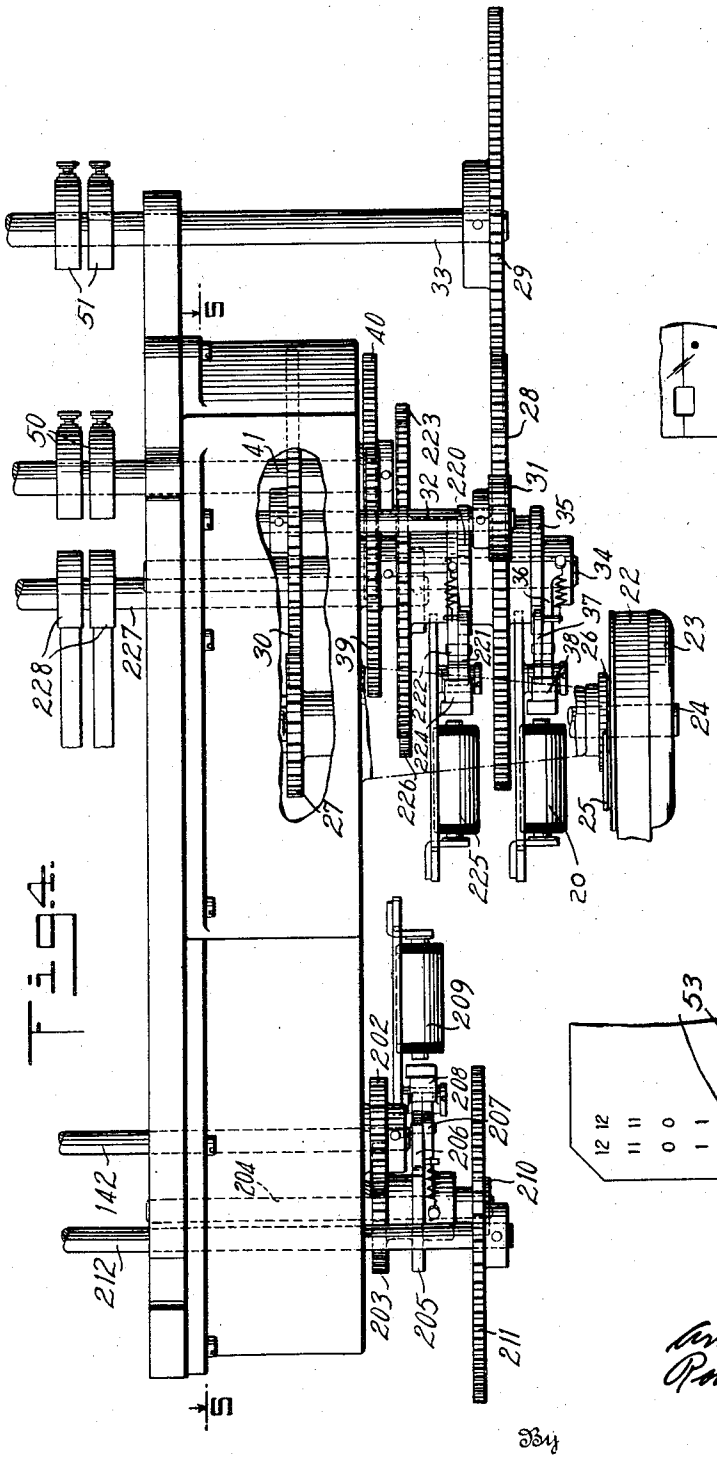

Fig. 4.

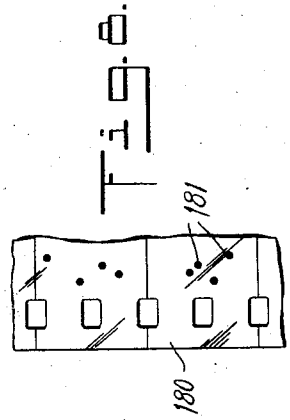

Fig. 6.

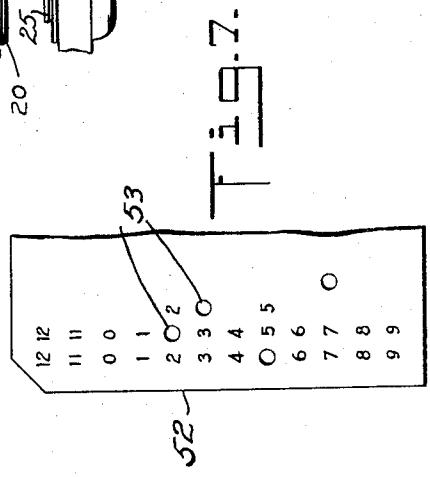

Fig. 7.

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DATA REPRODUCING MACHINE

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Fig. 5.

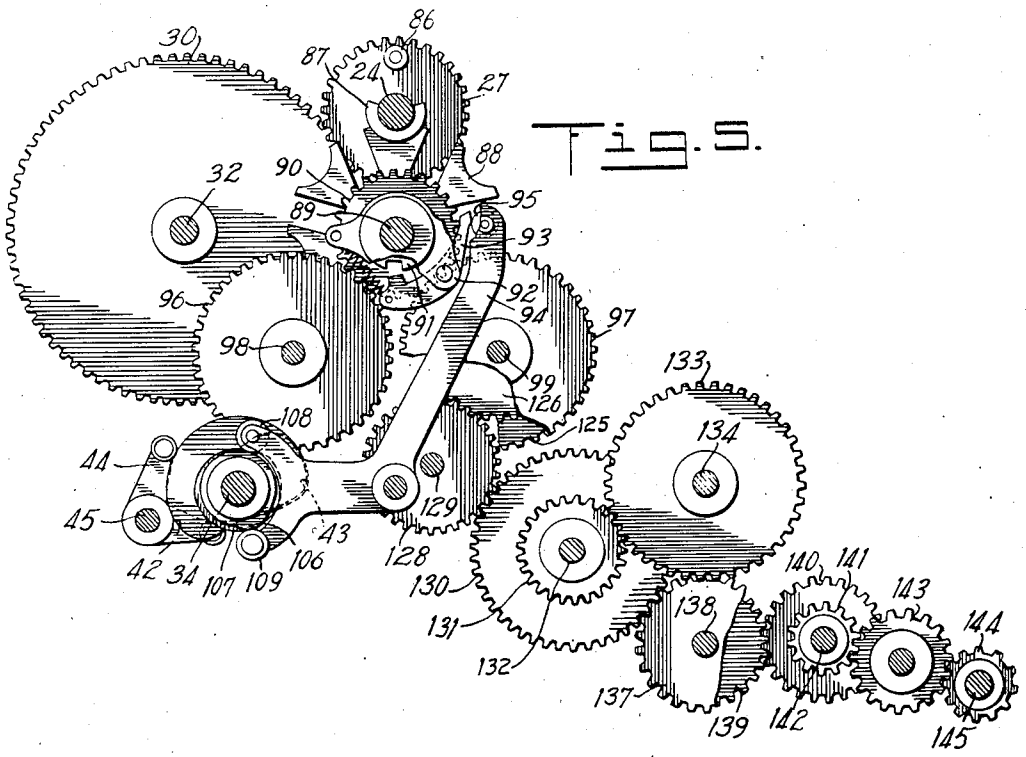
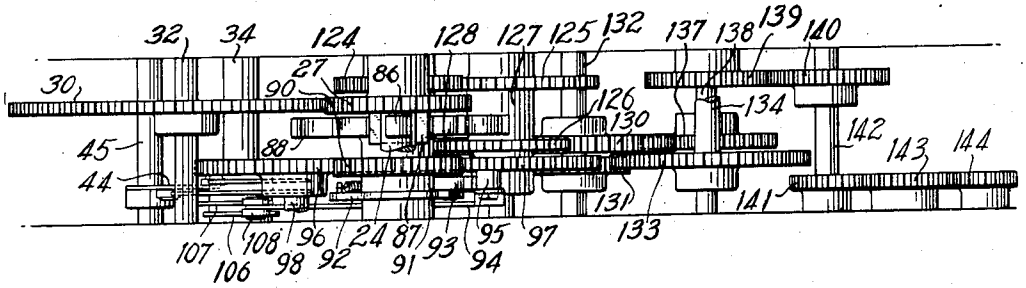


Fig. 6.



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DATA REPRODUCING MACHINE

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Fig 11.

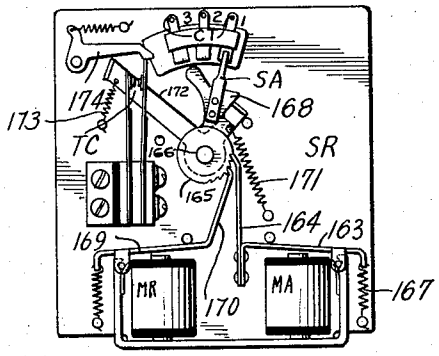
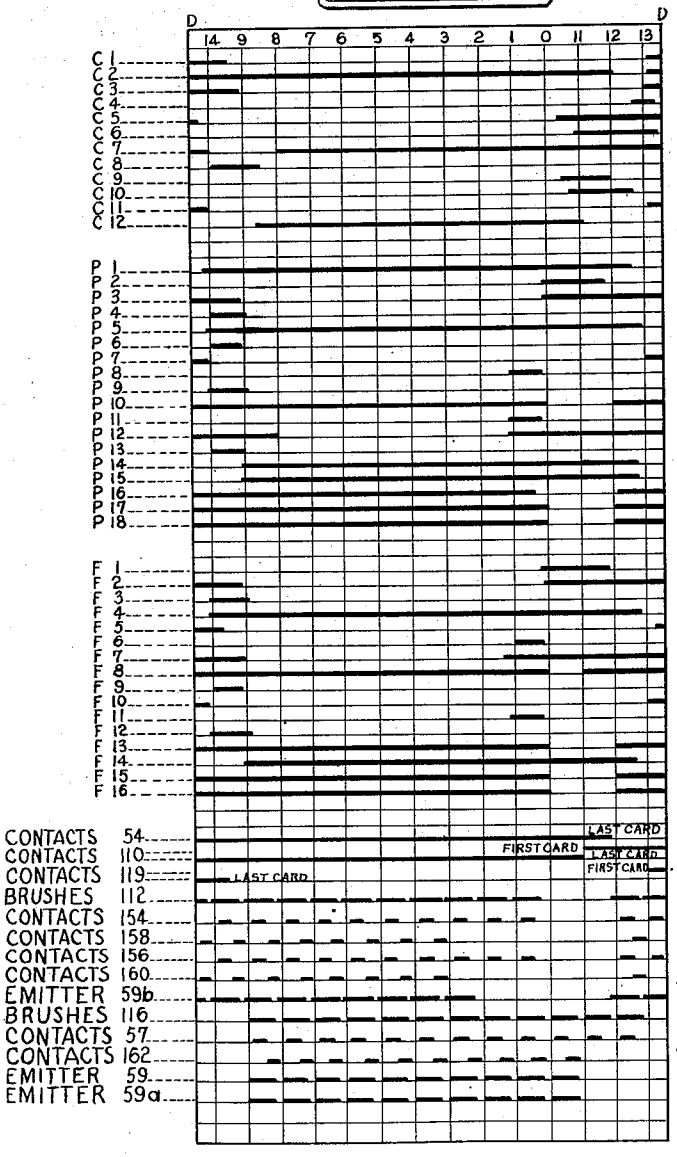


Fig 10.



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DATA REPRODUCING MACHINE

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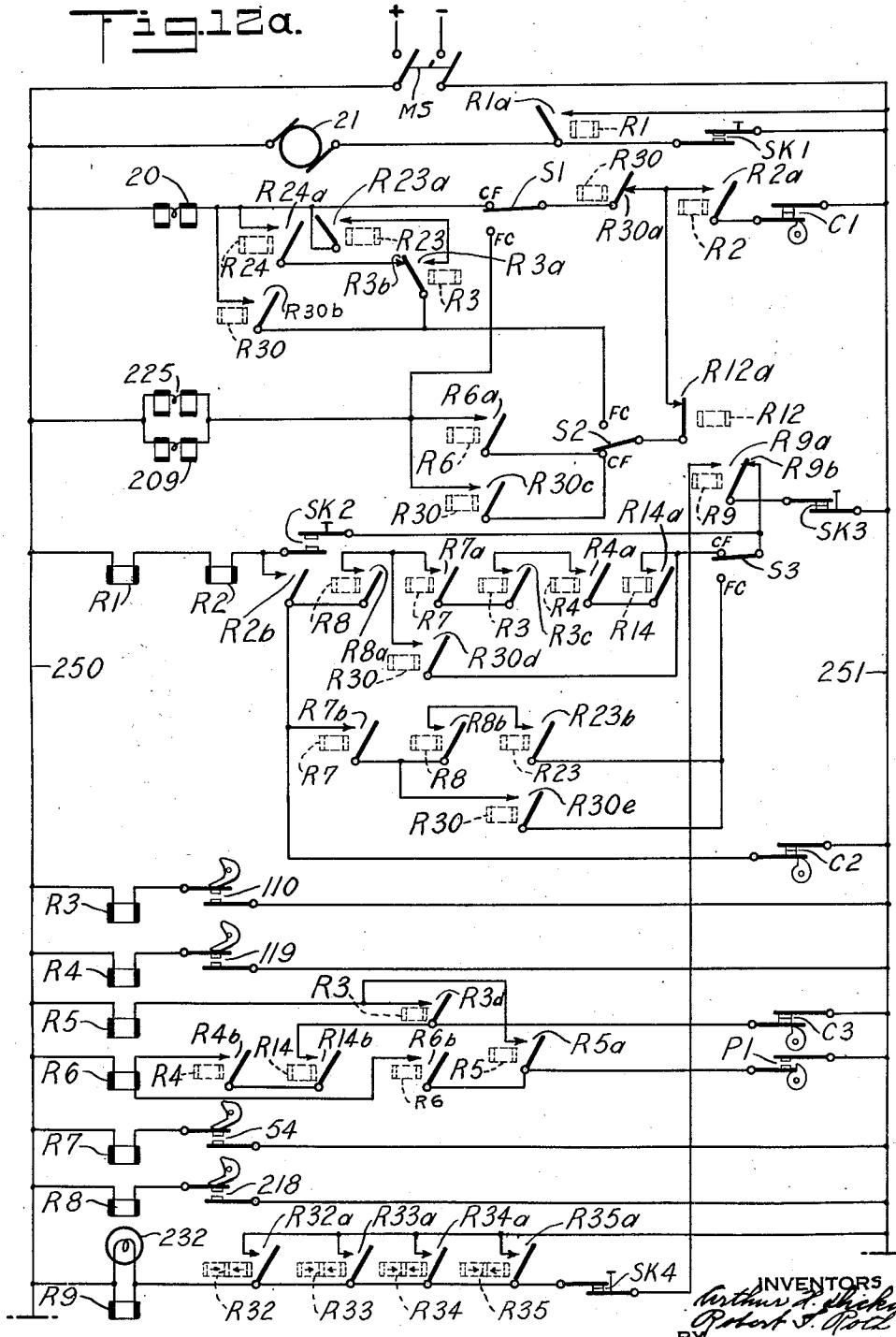
Fig. 12a.



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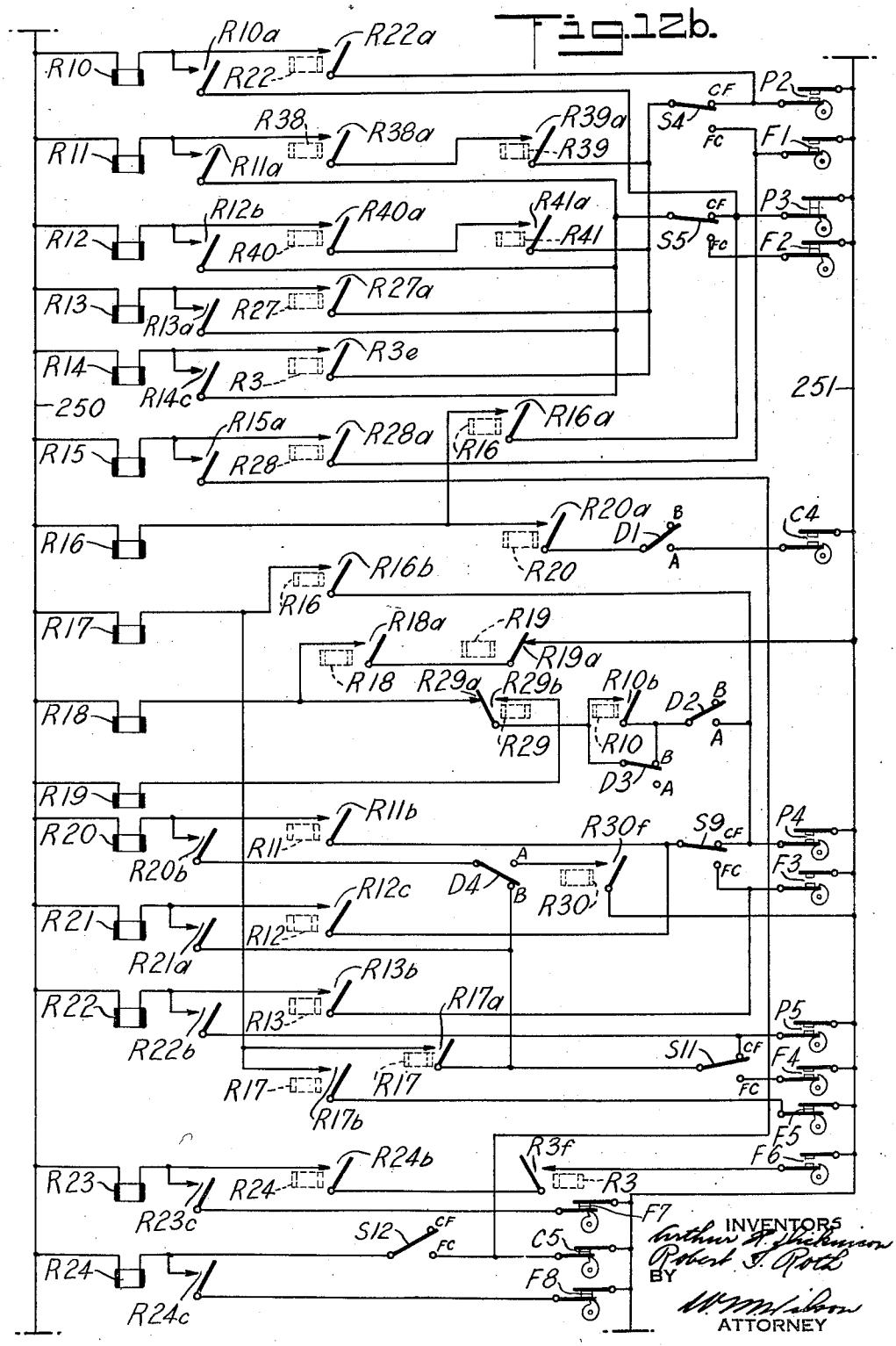
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 8

Fig. 12b.



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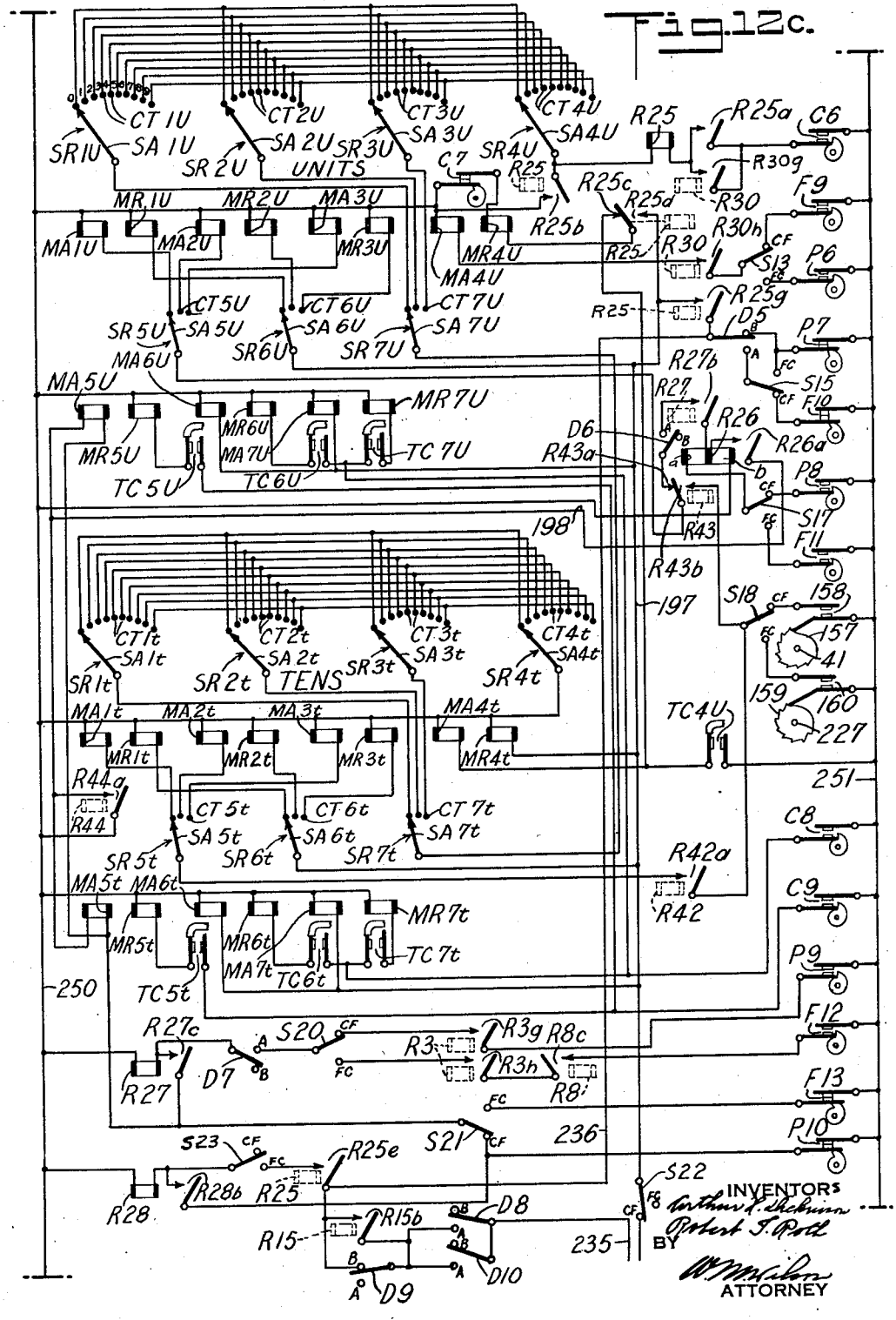
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 9

Fig. 12c.



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DATA REPRODUCING MACHINE

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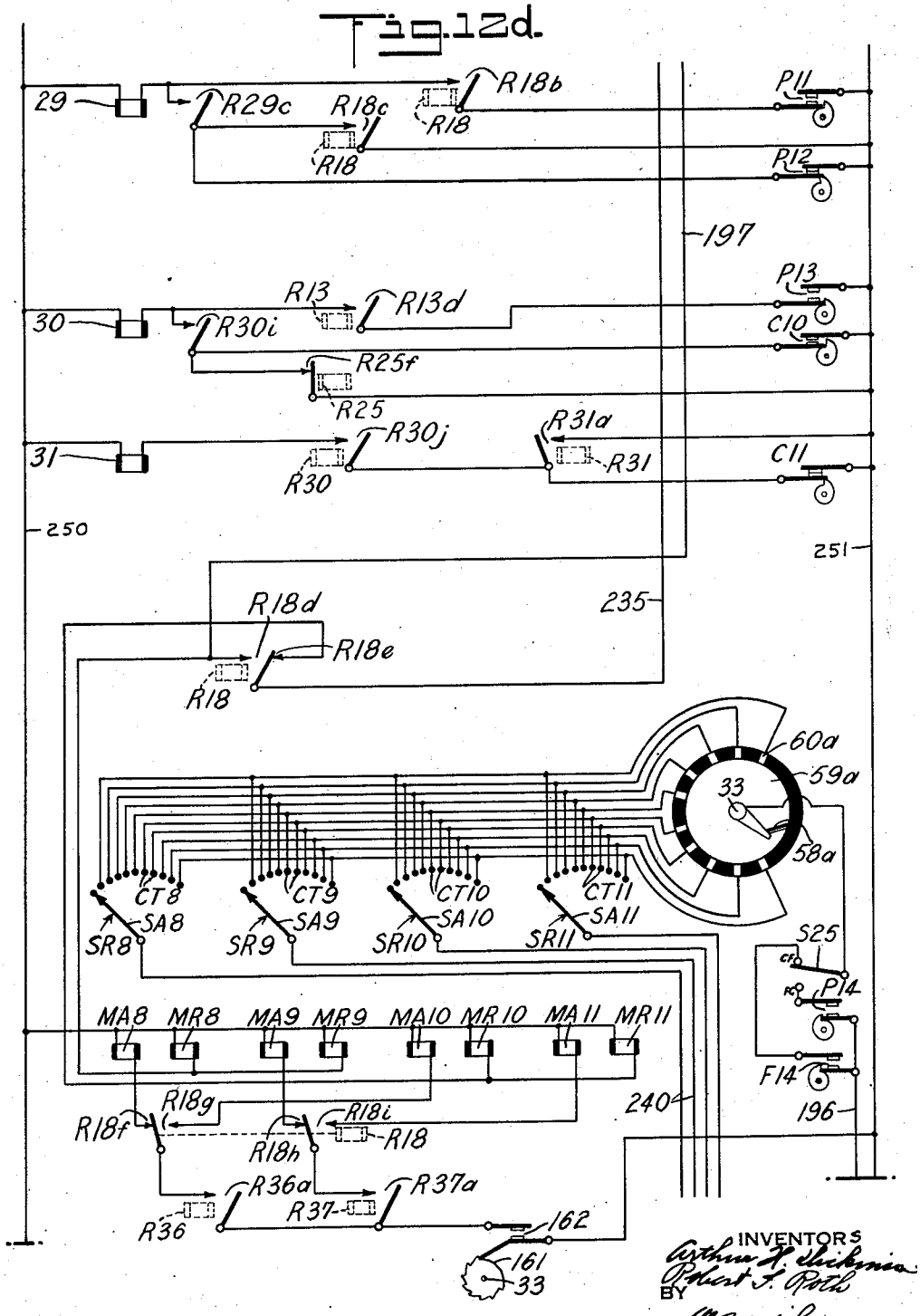
Fig. 12d.



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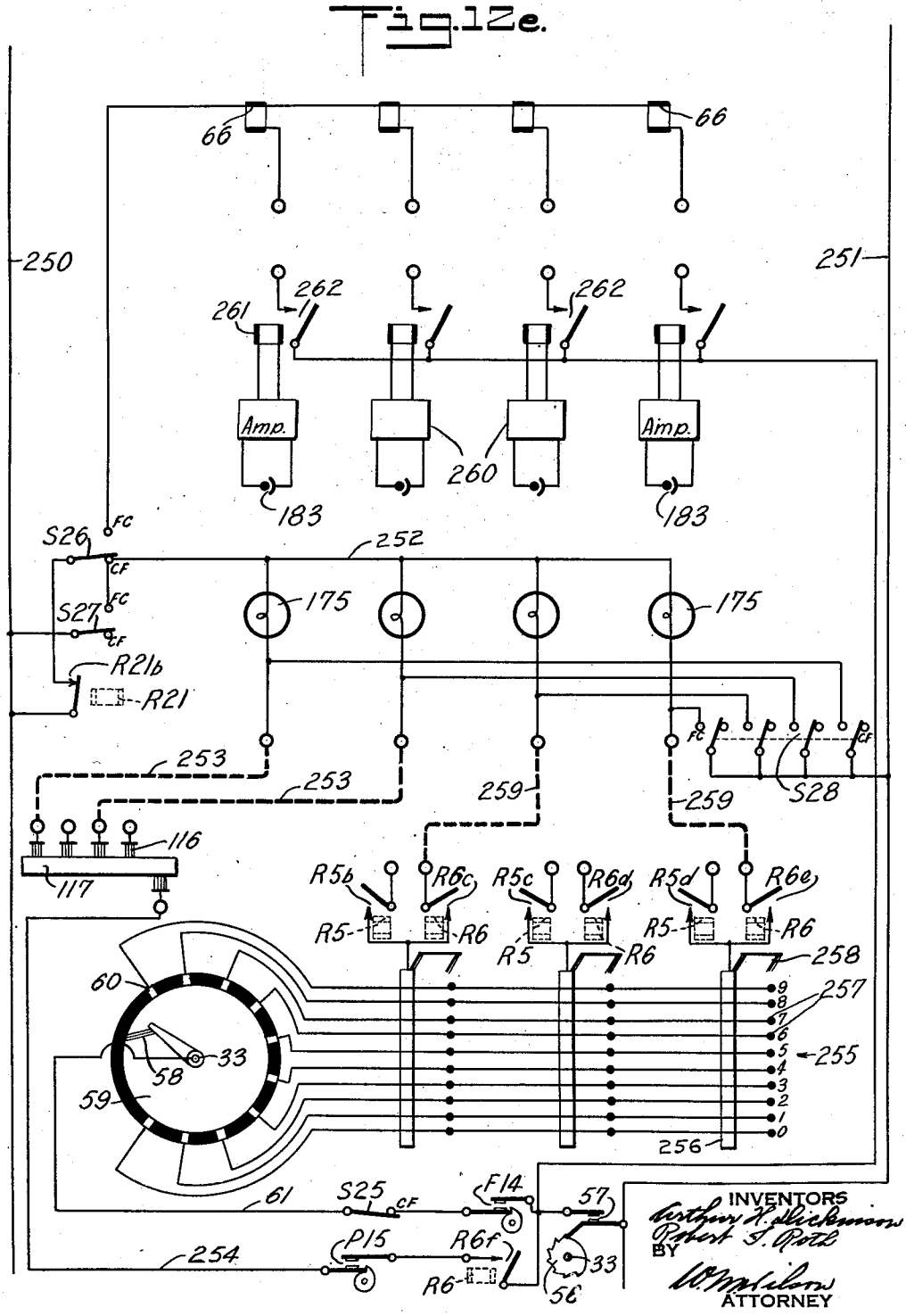
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 11

Fig. 12e.



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DATA REPRODUCING MACHINE

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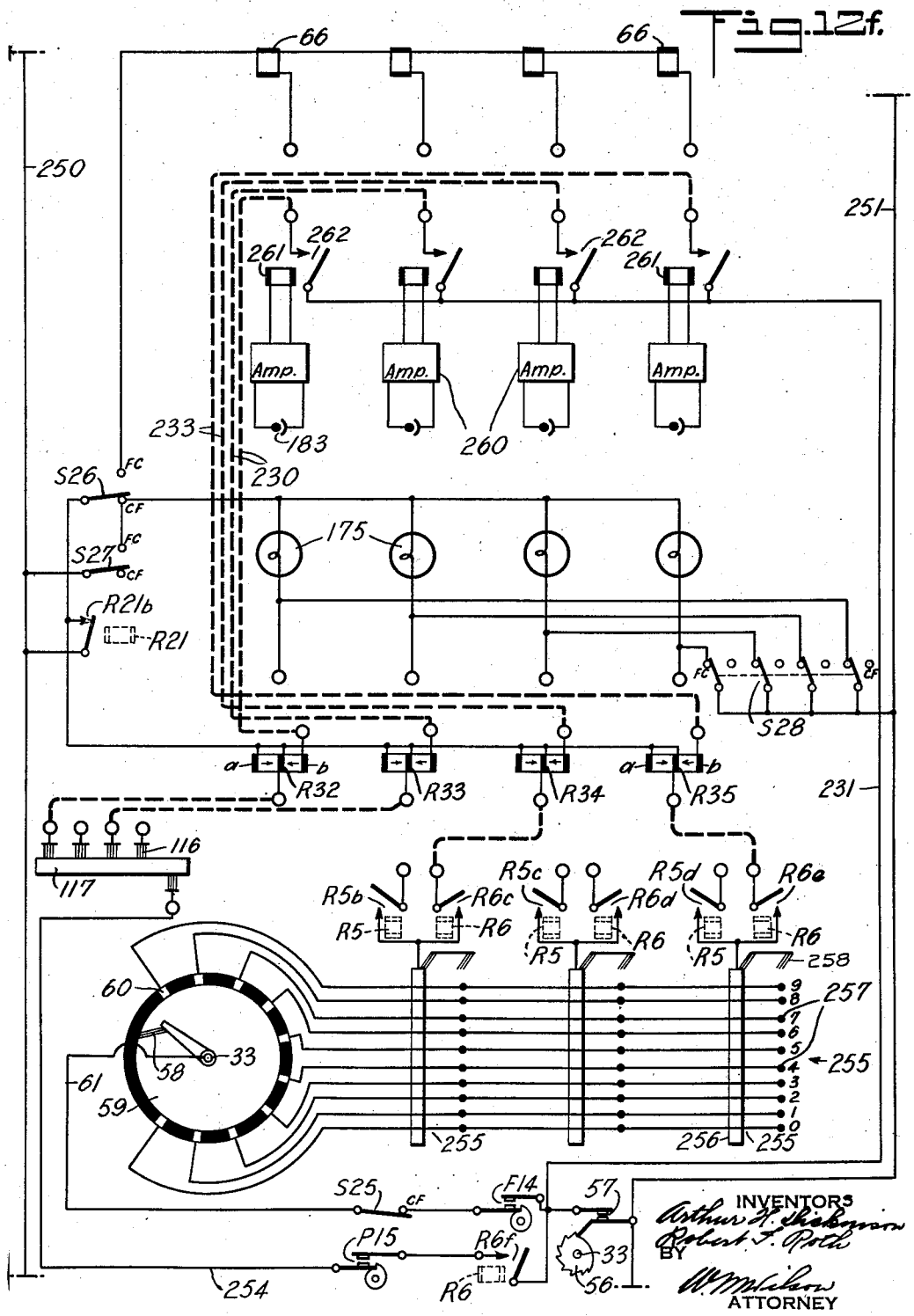
Fig. 12f.



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DATA REPRODUCING MACHINE

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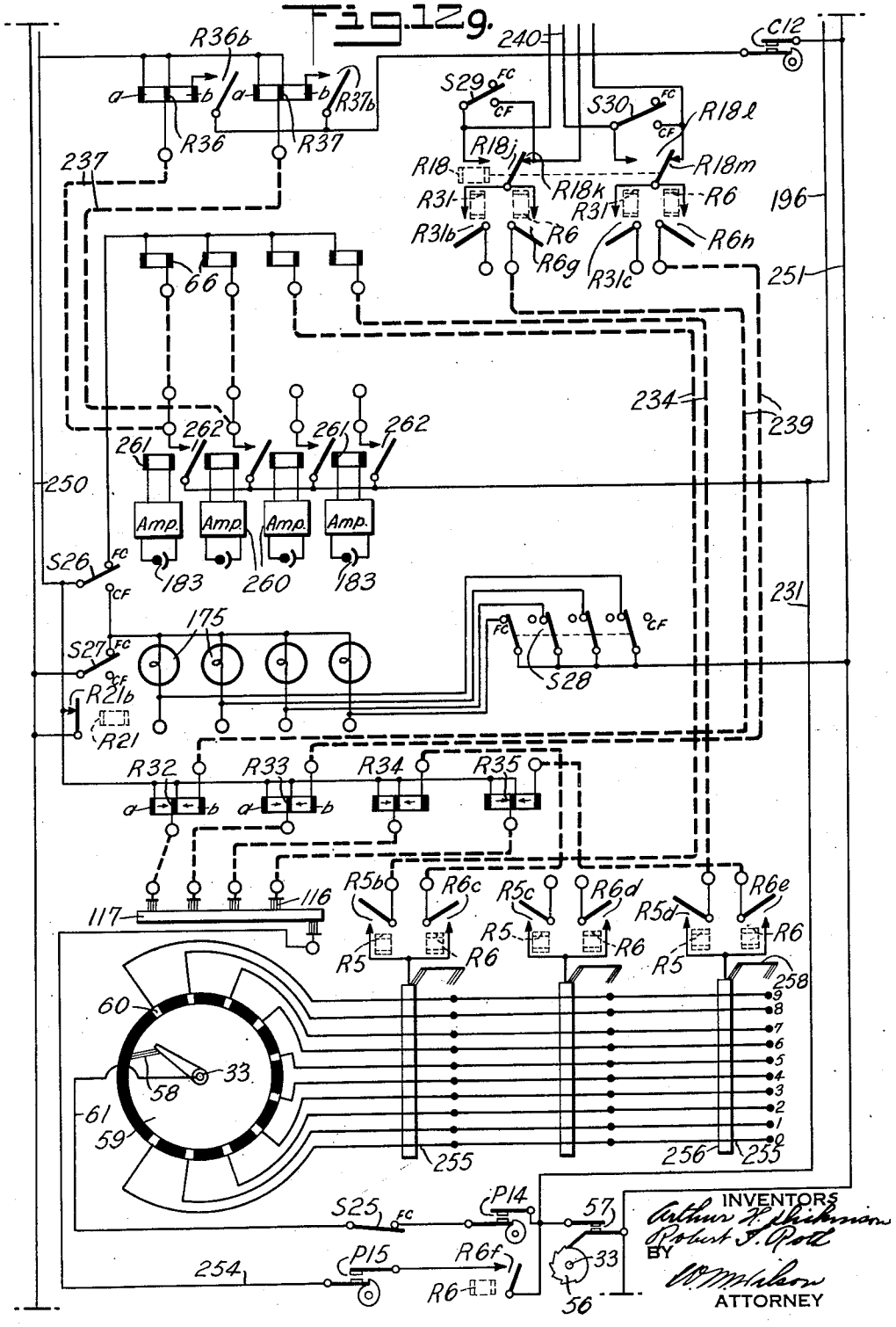
Fig. 129.



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DATA REPRODUCING MACHINE

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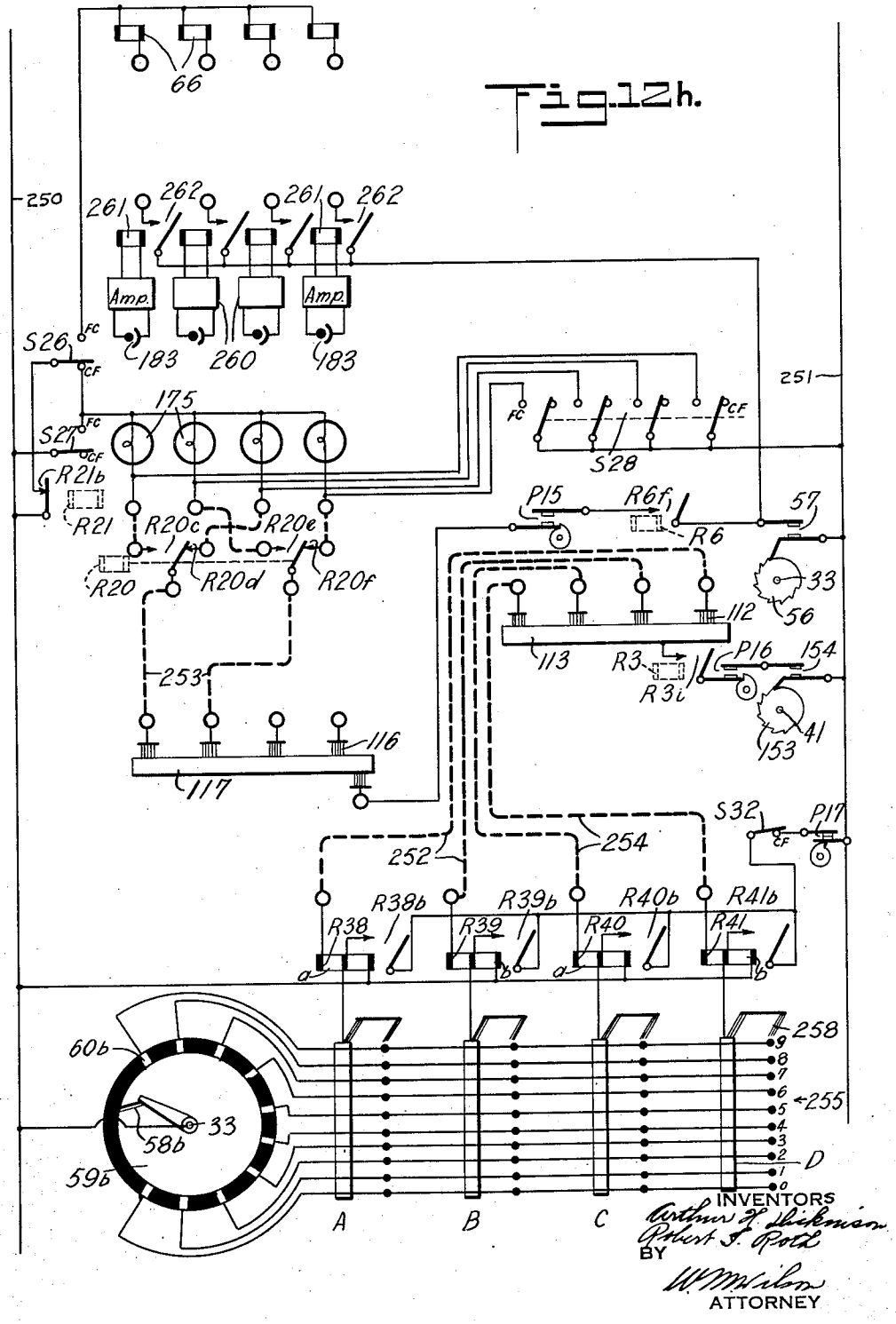

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DATA REPRODUCING MACHINE

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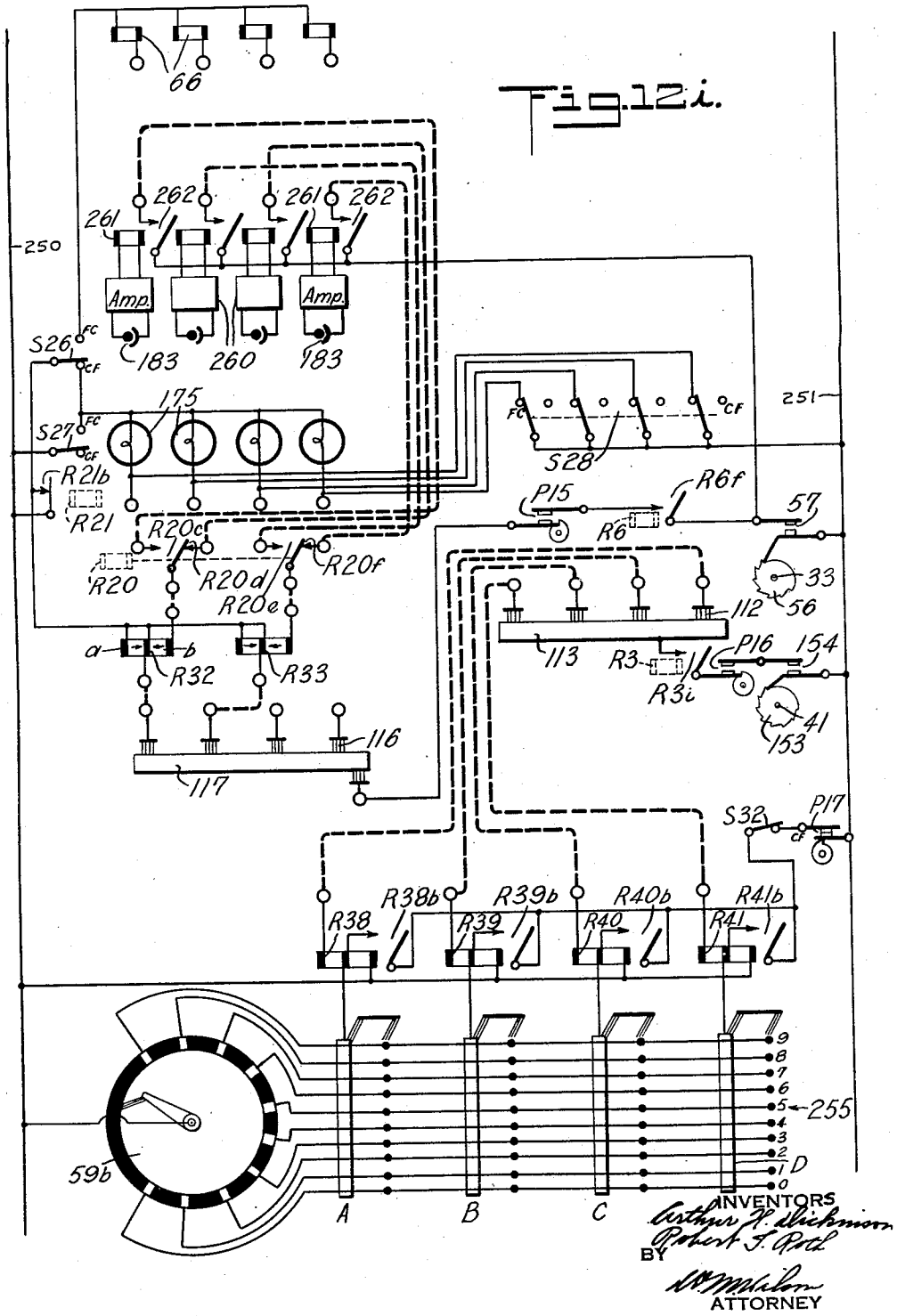
Fig. 12i.



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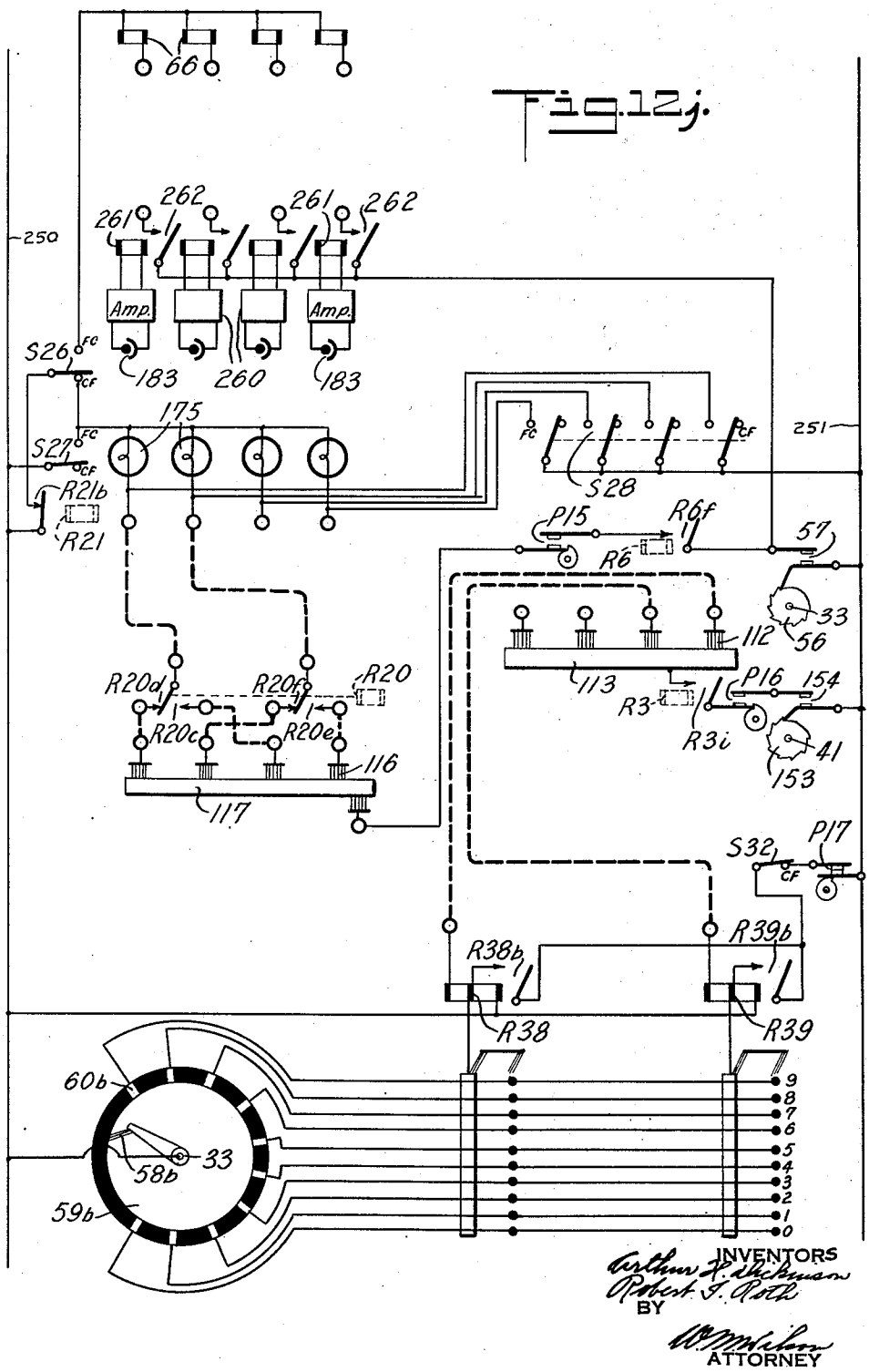
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 16



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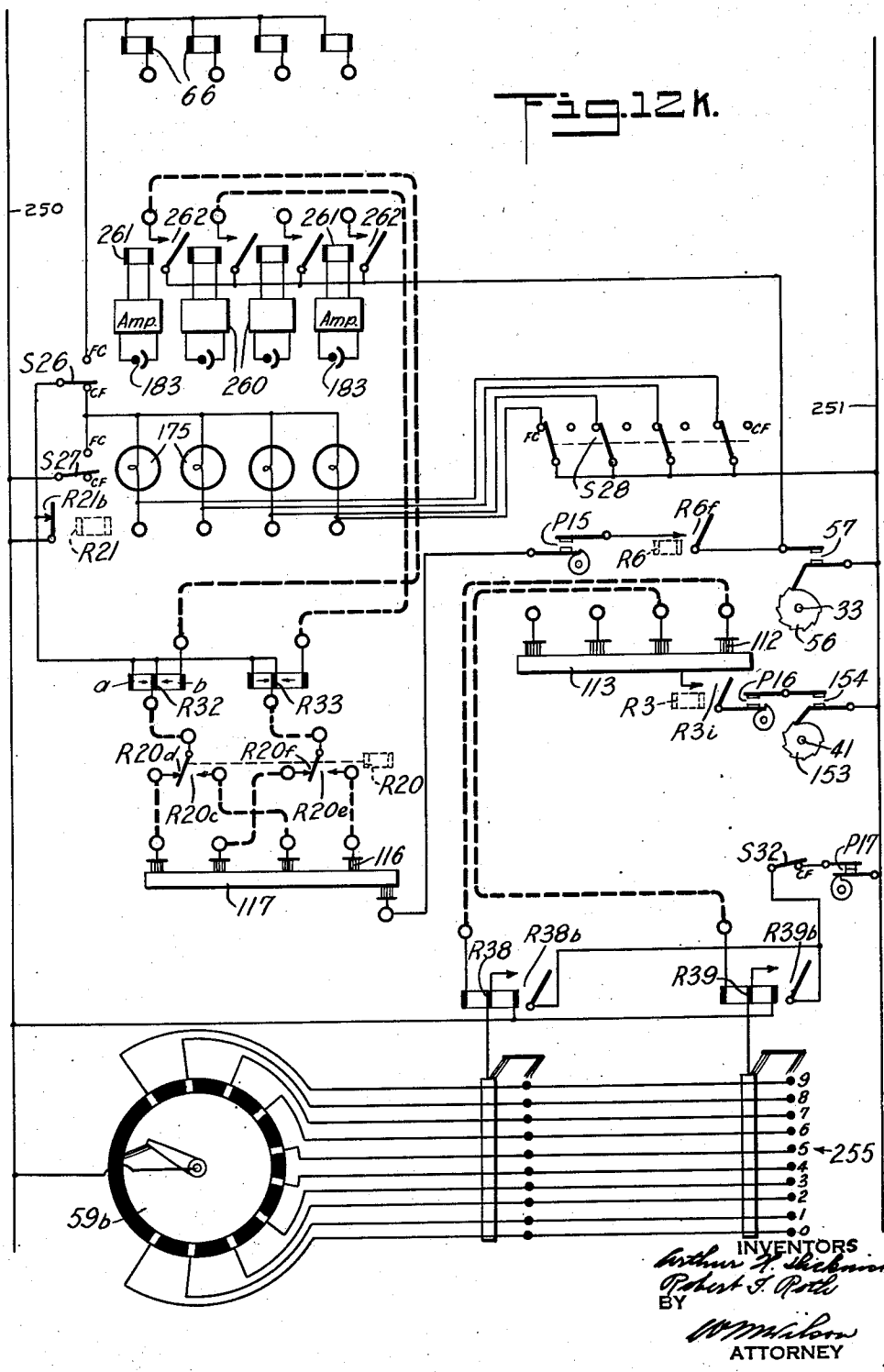
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 17



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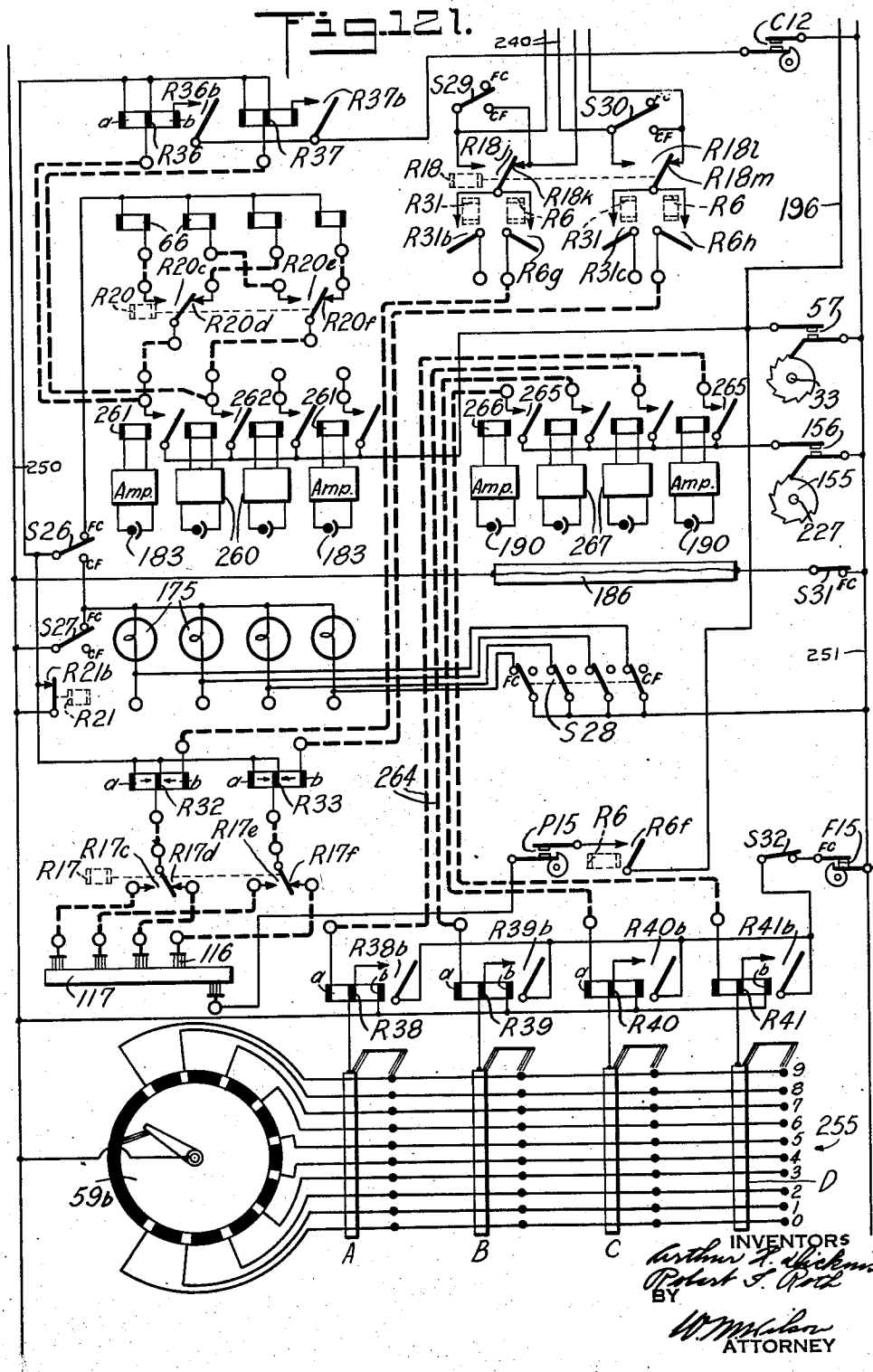
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 18

Fig. 12l.



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DATA REPRODUCING MACHINE

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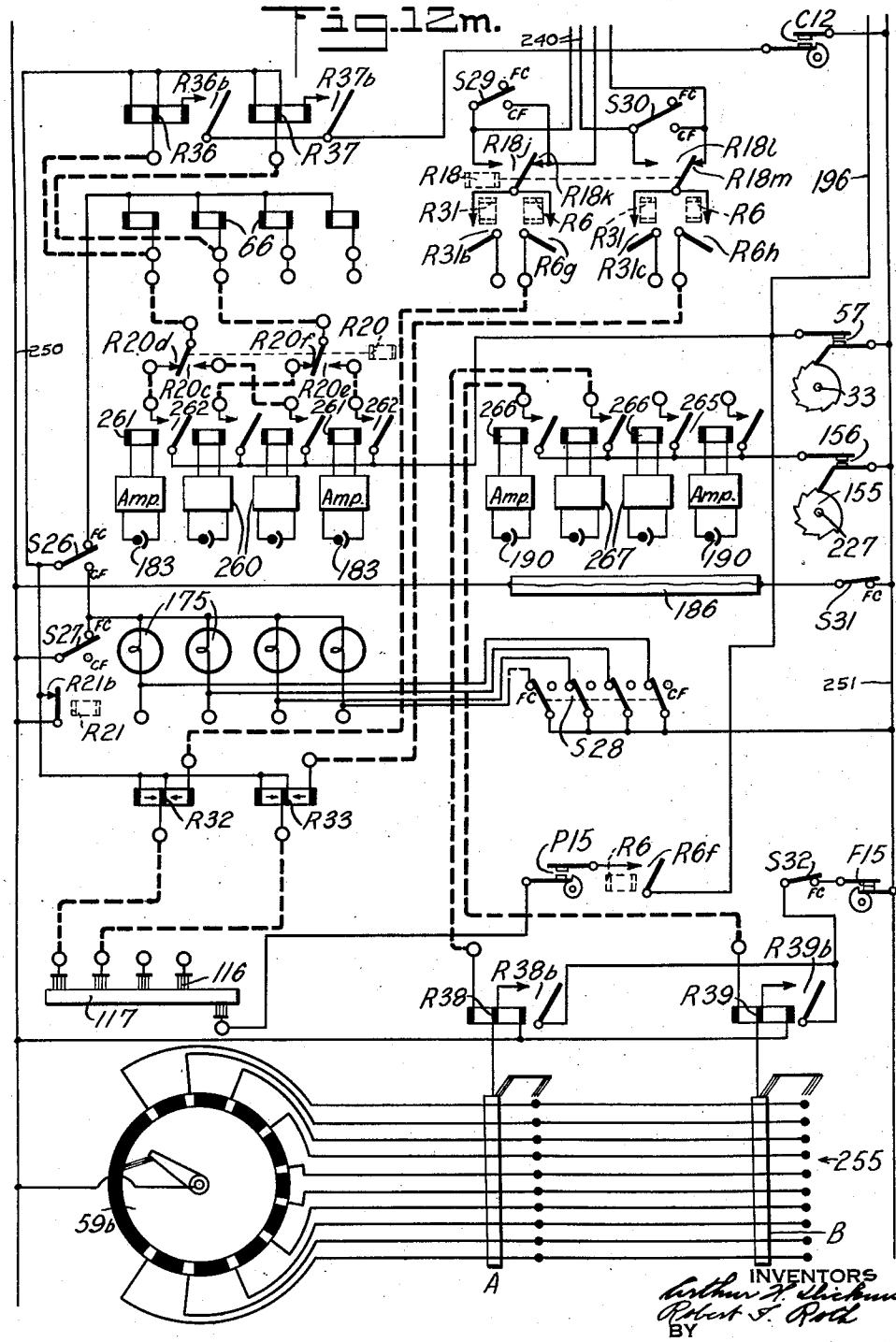
Fig. 12m.



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DATA REPRODUCING MACHINE

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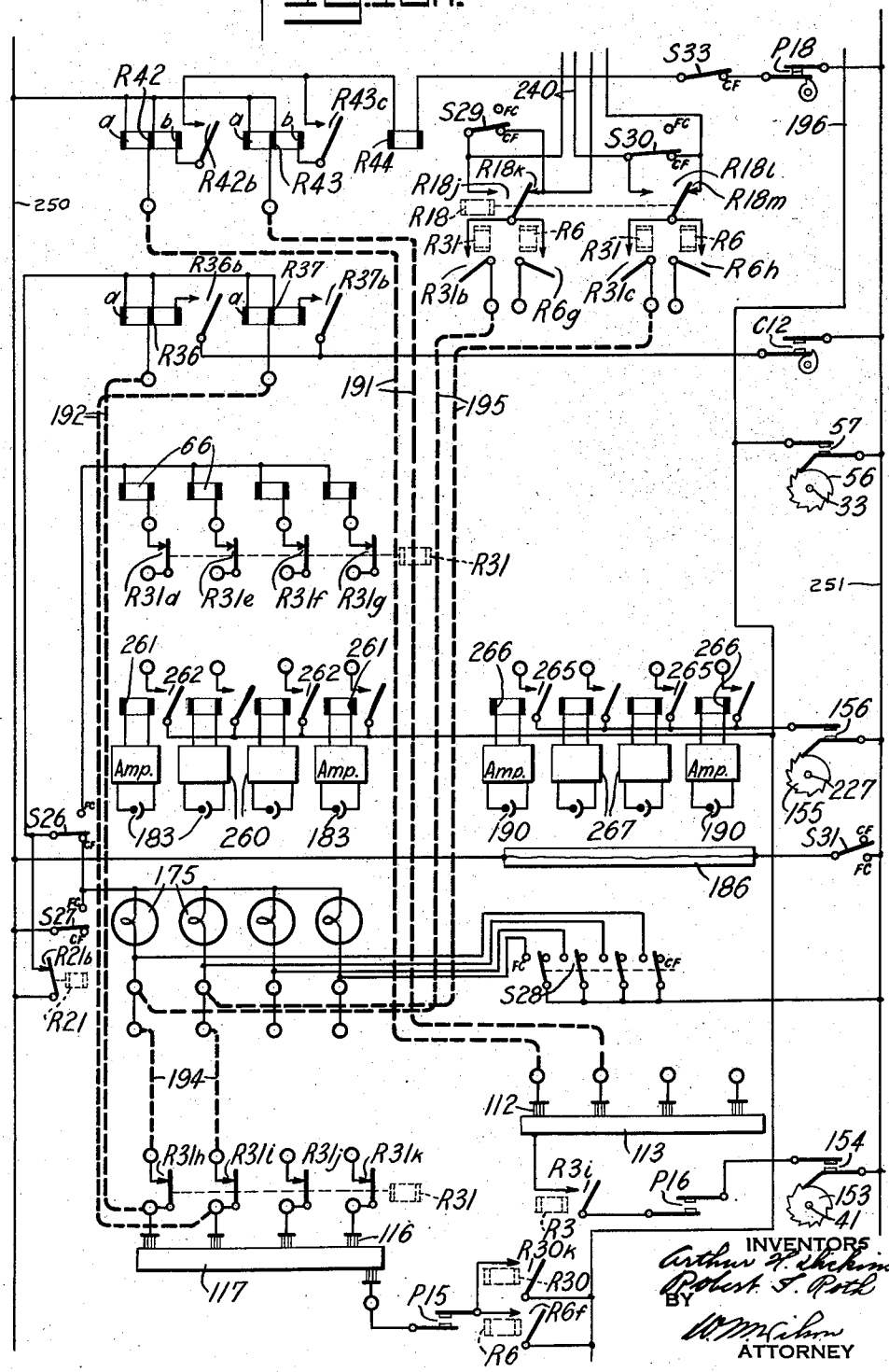
Fig. 12h.

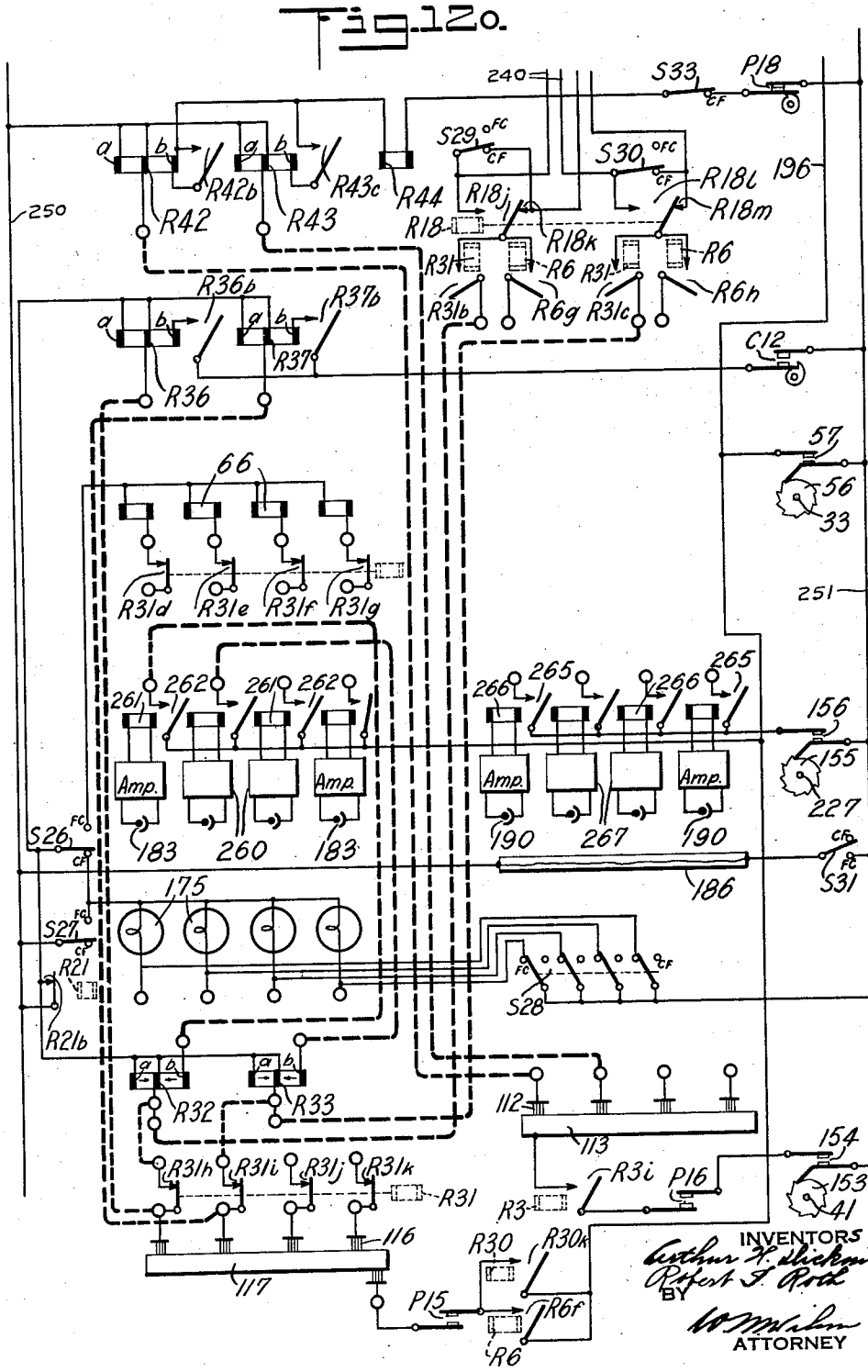


Dec. 10, 1940. A. H. DICKINSON ET AL 2,224,764

DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 21

Fig. 12a.



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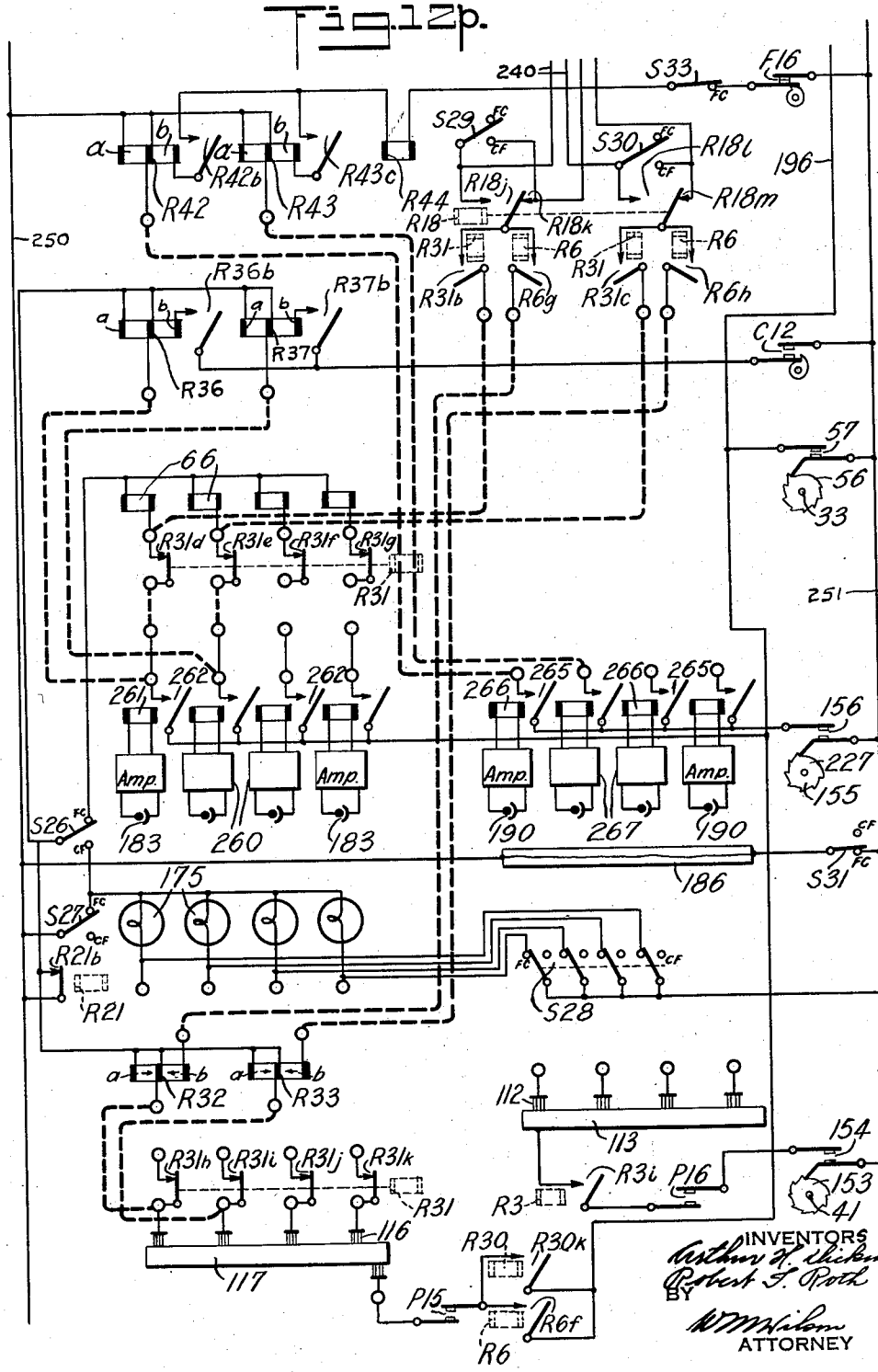
DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 22

Fig. 12b.



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DATA REPRODUCING MACHINE

Filed June 16, 1939 23 Sheets-Sheet 23

Fig. 1a.

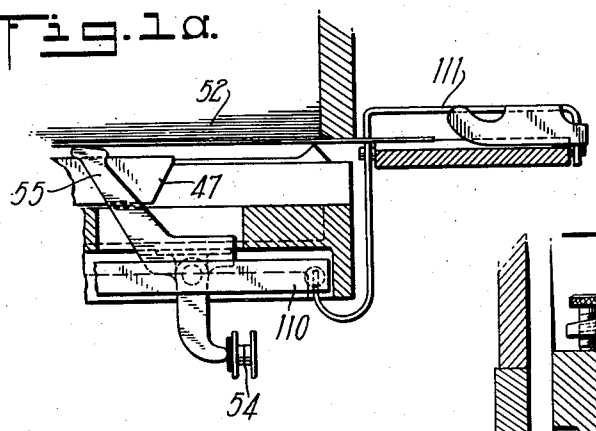


Fig. 1d.

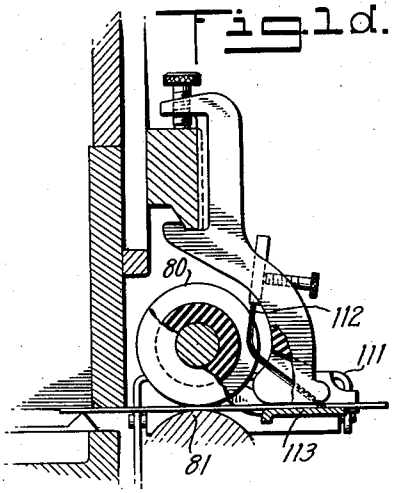


Fig. 1b.

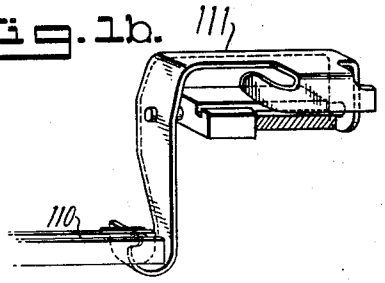


Fig. 2a.

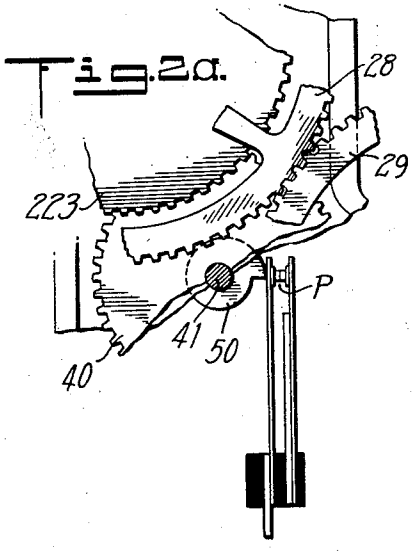
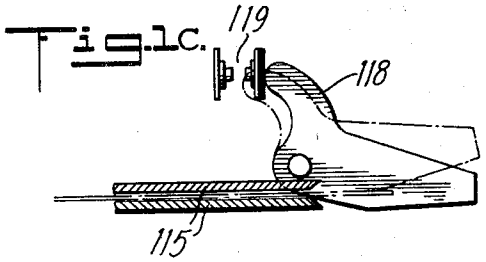


Fig. 1c.



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Patented Dec. 10, 1940 2,224,764

UNITED STATES PATENT OFFICE

2,224,764

DATA REPRODUCING MACHINE

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Application June 16, 1939, Serial No. 279,506

19 Claims. (Cl. 164—115)

This invention relates to a data reproducing machine and more particularly to a machine capable of reproducing coded data representations from one type of carrying medium to another and different type of carrying medium. The present invention is an improvement of applicants' copending application Serial No. 279,503 filed June 16, 1939.

The data carrying mediums may be of the types, or forms, suitably adapted for the automatic control of well-known types of machines, such as, statistical machines, typewriting machines, or the like. For example, in mechanized accounting systems, employing various types of known statistical machines, record cards, having data representations disposed thereon, are used for controlling the operations of the machines used in such systems; when utilizing the well-known Hollerith type of statistical card, the data representations usually are in the forms of perforations, which are formed at different columnar index point positions. The codes employed may be of different types, such as the combinational perforation code system, or single perforation code system.

It has been suggested to employ different types of control records other than the perforated record cards, for controlling the machines referred to, for example, one type suggested being a record medium having a layer of light sensitive emulsion disposed thereon which, when exposed to suitable recording mechanisms, and properly conditioned, is adapted to bear the data representations in the form of imperforate control spots disposed in various code positions thereon. These control spots, or index points, may then serve as light modifying or modulating areas for controlling the statistical or other operations of the machines.

It has been found, that, when it is desired to employ such machines controlled by different types of control records, provision must be made, whereby the data representations carried by one type of records can be reproduced, and formed on the other type of records, or vice versa. To simplify the description to follow, the illustration and disclosure thereof, will be limited to suitable mechanism, which may be conditioned so that the data representations, in the form of coded perforations on a record control card, can be reproduced on a photographic control record, in the form of differentially positioned control spots, or vice versa. These features broadly are shown and claimed in the said copending application.

In addition thereto, provision is made, whereby checking operations can be effected for a number of different types of card to film, or film to card operations. The checking operations consist of verifying the data, recorded on one type of record medium, with the original data, from which the medium has been produced. For the examples to follow, employing card sensing and film recording operation, it is necessary to develop the film record, upon which recording has been effected, and then run the developed film record through the machine, comparing the data recorded thereon with the punched data on the individual record cards, which are fed through the machine, in the same order as during the film recording operations. Checking, or verifying, operations for film sensing and card perforating operations can be effected during the same run in which the cards are punched. Provision is made in the machine whereby, one cycle after the cards have been perforated, the said cards are sensed, and compared with the data sensed on the film record. For these verifying operations, it is necessary to store the data, sensed on the film record, in suitable data storing devices, so that the stored data can be compared with the data punched on the card, one cycle after the punching operations. A plurality of groups of data storing devices are provided, so that entry of the data sensed during the reproducing cycle can be effected, and also comparing the previously stored data with the card already punched.

In all the examples to follow, it will be seen, that comparing relays are used, which have differentially wound coils, and that the data to be compared is effective to control one of the coils of the relays, and the comparing data is effective to control the other of the relay coils, so that, as long as the compared data is in agreement the comparing relays remain inoperative, and permit further automatic and continuous operations of the machine; whereas if the data compared is in disagreement, the comparing relays are operated for interrupting the automatic operations of the machine, and controlling an indicator accordingly.

Therefore, one of the objects of the present invention resides in the provision of means which can be conditioned, whereby one type of record medium is sensed, and adapted to control thereby, the recording of the data on a different type of record medium, or vice versa, and for either type of record reproduction, checking the data recorded upon either medium with the

data on the other medium from which recording was effected.

Another object of the present invention resides in the provision of means, whereby recording operations can be effected from one type of record medium to another and different type of medium, including selective operations, such as, class and field selection, and record elimination operations, and checking the data recorded during such selected operations.

Another object of the present invention resides in the provision of means, whereby recording operations can be effected from one type of record medium to another and different type of medium, including selective operations, such as, reproducing a predetermined number of records from the other record in accordance with the control number represented on the last mentioned record, and checking the data recorded, and number of records produced during such operations.

Another object of the invention is the provision of means whereby photographic film record reproducing can be effected under control of record cards, or vice versa, and checking the data recorded during such operations.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a sectional elevation view of the machine showing the feeding, sensing and reproducing devices.

Fig. 1*a* is a detail view showing contacts **54** and the associated card lever **55**.

Fig. 1*b* is a detail perspective view showing the contacts **110** and the associated card lever **111**.

Fig. 1*c* is a detail view showing contacts **119** and the associated lever **118**.

Fig. 1*d* is a detail view showing the brushes **112** and associated contact plate **113**.

Fig. 2 is a rear elevation view of the machine showing the driving and associated gearing mechanism.

Fig. 2*a* is a detail view showing the cam controlled contacts P.

Fig. 3 is an end elevation view of the mechanism shown in Fig. 2.

Fig. 4 is a plan view of the driving and associated gearing mechanism.

Fig. 5 is a sectional view along the lines **5—5** of Fig. 4.

Fig. 6 is a plan view of the gearing shown in Fig. 5.

Figs. 7 and 8 are detail views of several types of data carrying mediums.

Fig. 9 is a detail view of the card stacker drum.

Fig. 10 represents a timing chart of several elements of the machine.

Fig. 11 is a detail view of one form of stepping relay.

Figs. 12*a* and 12*b* taken alternately and singly with Figs. 12*e*, 12*f*, 12*h*, 12*j*, 12*l*, and 12*k* form different wiring diagrams of the machine and Figs. 12*a* to 12*d* taken alternately and singly with Figs. 12*g*, 12*l*, 12*m*, 12*n*, 12*o* and 12*p* form different wiring diagrams of the machine.

General Description

Briefly and broadly, the instant application discloses, by way of illustration, record card sensing and recording means, photographic film sensing and recording means, and associated control elements, all of which, when suitably conditioned render the device effective, (1) for sensing the data representations, in the form of perforations on the record card, and thereafter, controlling the film recording means, at differential times, thereby reproducing the sensed data representations on the photographic film, in the form of discrete control spots in different index point positions, (2) for sensing the differentially positioned control spots on the photographic film to control the record card perforating or recording means, at differential times, thus reproducing the data representations sensed on the record cards in the form of differentially displaced perforations, or the like; and (3) for checking the data recorded during any of the selected operations.

Referring now to Fig. 1, the data reproducing mechanism, or device, is shown to comprise a record card magazine, or supply hopper M, from which the cards are fed, singly, by the card feeding means, comprising in part, the card picker **47** and **48** and actuating arm **46** therefor, to the feed rollers **80** to **83**, past the card sensing station, including the brushes **116**, to the card drum **120**, feed rollers **122** and **123**, and card stacking magazine, or hopper N. Interposed between the pairs of feed rollers **80**, **81** and **82**, **83** is shown a suitable type of card recording means, for example, the punch plungers **65** and control magnets **66** therefor, and an additional card sensing station including the brushes **112**.

The photographic film **180** is fed, by means of the driving sprockets **213**, from a supply reel **200** past a suitable sensing and recording station, comprising the individual light sources **175**, associated light conducting quartz rods **177** and **182**, and suitable light responsive means, such as photo-cells **183**, and an additional sensing station, comprising light source **186**, quartz rods **188**, **189**, and photo-cells **190** to a suitably disposed take-up reel **201**.

Suitable control and conditioning means are provided, so that the control units referred to can be conditioned, whereby the cards are fed, singly, from the supply magazine to the card sensing station. At the card sensing station the perforations on the record cards are sensed, at differential times, for controlling the energization of the corresponding individual light sources, at the said differential times, for effecting the recording of the control spots on the photographic film. The mentioned control units can also be conditioned, so that the control spots on the photographic film are sensed, at differential times, for controlling the operation of the associated photo-cells, which photo-cells in turn are effective to control the card perforating control magnets, thereby effecting perforation of the record cards, in accordance with the data sensed.

Suitable additional control means are provided, whereby checking operations can be effected for verifying the data recorded either upon the record cards, or film records with the data from which recording was effected.

By referring to Figs. 7 and 8, facsimiles of portions of the perforated record cards and recorded photographic film are shown. In Fig. 7, the reference character **53** represents the differentially disposed perforations on the record card **52**, whereas in Fig. 8, the reference character **181** represents the differentially disposed control spots, or light modifying areas on the control film record **180**.

Record card feeding means

Referring now to Figs. 1 to 4, it will be shown, how the card feed magnets 20 control the operation of the record card feeding means. A motor 21 (Fig. 12a), suitably mounted in the machine, is effective to rotate the shaft 24, by means of the interconnecting belt 22, pulley 23, pawl 25 secured to said pulley, and ratchet 26, which is secured to shaft 24, and engaged by the pawl 25. In this manner, the shaft 24 is rotated continuously as long as the motor is operated. Gear 27, attached to the shaft 24, is effective to drive gears 28 and 29, by means of the interconnecting gears 30 and 31, both of which are affixed securely to shaft 32. Gear 29 is secured to shaft 33, thus it is seen, that shafts 32 and 33 are arranged to be rotated continuously, similarly as shaft 24, as long as the motor is operated. A single tooth ratchet 35 is adapted to be secured to gear 28, both gear and ratchet being rotatably mounted on the supporting shaft 34, and to which shaft an arm 36 is attached. A spring actuated dog 37 is pivotally mounted on the arm 36, and arranged to be held out of engagement with the ratchet 35, by the armature 38 associated with, and controlled by the magnets 20. From the description thus far, it is understood, that upon energization of the magnet 20, the associated armature 38 is displaced, sufficiently out of the path of dog 37 and arm 36, to release these elements, and permit the dog 37 to engage the single tooth of ratchet 35, thus effecting rotation of the shaft 34, by means of the ratchet and associated gearing. Shaft 34 is rotated, as long as the magnet 20 remains energized, and in turn, effects rotation of gear 39 attached thereto, gear 40 and shaft 41 to which the last mentioned gear is secured.

Complementary cams 42 and 43 (see Fig. 5) are mounted on shaft 34, and are arranged to displace the two armed lever 44 on shaft 45, thereby rocking shaft 45 and the sector arms 46 (Fig. 1) attached thereto. The said sector arms are provided with gear teeth which mesh with racks on the card picker slides 47. A knife edge 48, attached to the slides, is adapted to engage the bottom card in the supply magazine, or hopper M, and displace the card to the right (Fig. 1), when the picker slide is reciprocated by the cams 42 and 43 on shaft 34. The ratio of the described gearing is such that gear 28 rotates one revolution for each card cycle. Associated with the card hopper M are the contacts 54 (Fig. 1a) controlled by the lever 55, which contacts are adapted to remain closed, as long as cards are provided in the supply hopper, and upon exhaustion thereof, the said lever is permitted to swing in a clockwise direction to open the said contacts.

Upon deenergization of the magnet 20, the spring-urged armature 28 is positioned in the path of dog 37 and arm 36, so that disengagement of dog 37 and ratchet 35 is effected. A locking lever 49 is provided to maintain arm 36 in a predetermined position, thus locking the shafts 34 and 41 in the normal "D" or home position (see Fig. 10).

It should be mentioned, that cam elements 50 are provided, on the shaft 41 (Figs. 2 and 2a) to control the associated cam controlled contacts P1 to P5; and that shaft 33 carries cam elements 51 to control the associated cam controlled contacts C1 to C4. Upon shaft 33 a suitable cam 56 (see Figs. 4 and 11—B) is mounted, which is adapted to operate the associated contacts 57, at different times, during the machine cycle (see Fig. 10), and in addition thereto, the brushes 58 of a well-known type of impulse emitters 59 (see circuit diagrams) are secured to the said shaft, so that the individual conducting segments 60 are connected to the common conducting ring 61, at different times, during the machine cycle, by means of the rotated brushes, the purpose of which will be described later.

It has now been shown, how the record cards 52 are fed singly from the supply hopper M, by means of the card picker mechanism, whenever the control magnet 20 is energized. For further detailed description of the card feeding mechanism reference may be made to U. S. Reissue Patent #21,133 dated June 27, 1939, wherein elements similar to those just described are shown in detail. The individual record cards are now displaced and fed to the first set of feed rolls 80 and 81, which in turn, feed the cards past the card recording or perforating station. It will be shown, that the individual cards are positioned, intermittently, by the feed rollers, past the card recording station and the card sensing station. This mechanism will now be described in conjunction with the card recording or perforating means.

Record card recording means

Referring now to Fig. 1, the card recording station is shown to comprise recording means, illustrated in the form of record card perforating plungers 65, the operation of which, are selectively controlled by the magnets 66. The said magnets, upon energization, select the associated plungers so that, during the operation of the operating bar 67, the bar is adapted to depress or operate all the selected plungers, and thereby effect perforation of the record card. This operation is explained in detail, in the patent referred to hereinabove, and therefore the following brief description thereof is deemed sufficient. It is well known, that an individual plunger 65 and controlling magnet 66 are provided for each columnar area of the card, and that all the selected plungers are operated or depressed for all columnar areas simultaneously. It will be explained shortly, how the different index point positions of the cards are fed, intermittently, to the punching station, and that the perforating thereof is effected while the cards are stationary thereat.

The said plungers are shown provided with individual spring-urged pivoted interposer pawls 68, which are connected to the armatures 69 of the magnets, by call wires 70, so that, upon energization of a magnet, the connecting call wire is effective to swing the pawl 68 to the right, as viewed in Fig. 1, positioning the said pawl in the path of the operating bar 67. Upon depression of the said bar, which is adapted to cooperate with the notch 68a in the pawl, the related pawl is caused to be depressed to perforate the record card accordingly, and is then quickly withdrawn therefrom to permit feeding of the card to the next index point position.

The operating bar 67 is supported by a control bail 71 which is suitably pivoted on studs 72. The control bail is attached to arm 73, by means of an adjustable turnbuckle connection 74, said arm 73 being secured to shaft 75 which is also provided with an arm 76. An eccentric 77 is suitably disposed and formed on the shaft 24, which eccentric is encircled by an arm 78, the upper end of which is pivotally connected to the said arm 76.

It is now seen that, since the eccentric 77 is positioned on the constantly rotating shaft 24, shaft 75 and arm 73 are rocked to depress, at periodic intervals, the bail 71 and bar 67. As the said bail and bar are reciprocated, any of the pawls may be positioned by the call wires so as to effect engagement of the pawls and bar. Then, the connected pawls and plungers are depressed to perforate the card, and, withdrawn immediately therefrom to permit the feeding of the card. Referring to Fig. 7, a facsimile of a portion of a perforated record card 52 is shown, the index point positions for several columnar areas are shown to be provided with perforations 53 at different positions in the columnar areas to represent different data representations.

The feeding of the cards to, and from, the punching station is effected by the feed rollers 80, 81, 82 and 83. The cards are fed, intermittently, by rollers 80 and 81 between a stripper plate 84 and die plate 85, through which plates the plungers are adapted to be positioned.

The mechanism for operating the said feed rollers is as follows—referring now to Figs. 5 and 6, it is seen that the continuously rotated gear 27 (also see Fig. 2) is provided with a Geneva roller 86 and segment 87, which cooperate with a Geneva disc 88 fixed on shaft 89. The Geneva disc is provided with seven radial slots, so that one revolution of gear 27 will rotate the shaft 89, one-seventh of a revolution, which partial revolution corresponds to a movement of one cycle point of the record card. Shaft 89 rotates continuously, with an intermittent, motion as long as the motor 21 is operated. Rotatably mounted on the shaft 89 is a gear 90, which has affixed thereto a single tooth ratchet 91, and secured to the shaft 89 is an arm 92, upon which a spring-urged dog 93 is pivoted. The spring-urged dog normally tends to engage the ratchet 91, however, disengagement of the dog and ratchet is effected by the lever 94 and attached roller 95, which roller as shown in Fig. 5, engages the tail of the dog to position it, so as to prevent engagement thereof with the ratchet. When the said lever and roller are positioned to the right, as viewed in Fig. 5, and out of the path of the dog, the dog and ratchet are permitted to be engaged, thereby effecting rotation of gear 90 which is arranged to drive gears 96 and 97, which gears are fixed to shafts 98 and 99, respectively. Suitably disposed on shafts 98 and 99 (see Figs. 1 and 2) are gears 100 and 101 arranged to engage gears 102 and 103, which are pinned to shafts 104 and 105, respectively. Shafts 98 and 104 carry the first pair of feed rollers 80 and 81, respectively, whereas, the second pair of rollers 82 and 83 are carried by shafts 99 and 105, respectively.

It is evident now, that whenever the lever 94 is displaced out of the path of dog 93, engagement of the dog and ratchet 91 is effected to drive the feed rollers 80 to 83 intermittently, by means of the described gearing. As mentioned hereinabove, the gear ratio is such, that for each movement of shaft 89, the feed rollers are rotated to an extent sufficient to displace the card one cycle point, which displacement is equivalent to the distance between index point positions on the record card. The lever 94 is displaced, so as to release the dog 93, by the complementary cams 106 and 107 positioned on shaft 34, which cams are engaged by the rollers 108 and 109 carried by the horizontal portion of lever 94. It is remembered, that the rotation of shaft 34 is controlled by the magnet 20, and that whenever this magnet is energized, shaft 34 is rotated continuously by the shaft 24 and associated gearing, described hereinabove. The cams 106 and 107 are designed, so that, if the magnet 20 is not energized and the shaft 34 is not rotated, lever 94 is positioned in the path of the dog 93, thereby preventing the dog from engaging the driving ratchet 91. However, should the said magnet be energized, cams 106 and 107 are turned, lever 94 displaced, permitting engagement of the said dog and ratchet, and establishing a driving connection between the intermittently driven shaft 89 and gear 90 for effecting intermittent movement of the card feed rollers 80 to 83.

Adjacent to rollers 80 and 81 is suitably disposed a control lever 111, which lever is effective to close contacts 110 (See Figs. 1*a*, 1*b* and 12*a*). As long as cards are fed successively to, and from, the rollers 80 and 81, the said lever is adapted to maintain the contacts 110 closed, however, when cards are not fed successively thereto, the contacts are opened.

Record card sensing means

Referring now to Fig. 1, the record cards are fed from the recording station to a sensing station, by the rollers 82 and 83, through the guide plates 115, and past the suitably mounted sensing brushes 116 (also see circuit diagrams), cooperating with the conducting roller 117. It is understood, that the index point positions of the intermittently fed cards are positioned properly at the sensing station, so that, whenever perforations are present in the cards at particular index point positions, the corresponding sensing brushes are adapted to extend therethrough and engage the conducting roller, thereby completing the circuits associated with said brushes and roller. The controlling circuits thus established will be described later herein. A facsimile of a portion of a suitable perforated record card 52 is shown in Fig. 7 provided with the differentially positioned perforations 53.

It should be mentioned, that at this sensing station a suitable and a well known type of card lever 118 (see Fig. 1*c*) is provided for controlling the associated card lever contacts 119. Whenever a card is fed to, and present at the sensing station, the said card lever is operated by the cards to close the card lever contacts, and whenever no cards are present to engage the card lever, the card lever contacts are opened.

In addition to the described data sensing station, an additional sensing station is provided, comprising brushes 112 (see also Figs. 1*d* and 12*h*) and conducting plate 113, which are disposed adjacent to the feed rollers 80 and 81. This sensing station is provided to sense the control data disposed on the cards, and is employed whenever a predetermined number of record reproducing operations is effected. The brushes 112 are carried in a holding frame 114, which may be selectively positioned on the supporting bar 63, so that the control data in any desired fields of the record cards can be sensed and, due to the disposition of these brushes with respect to the amount data sensing brushes 116, the control data on a card, presented at the said additional sensing station is sensed prior to the sensing of the amount data on the same card, when presented to the main sensing station. In this manner, control circuits may be controlled by the control data sensed, thus conditioning certain circuits, which at a later time, are controlled by the

second sensing station. The said additional or auxiliary sensing station (including brushes 112), in the instant application, is used solely for sensing the control data, whereas the second or main sensing station (including brushes 116) is used for sensing the data to be reproduced. This description is made at this time, so that hereafter, the card sensing stations will be referred to as the main and auxiliary card sensing stations.

Record card stacking means

From the main sensing station, the cards are fed to a hopper N (Fig. 1), by means of the card stacker drum 120, and associated feed roller 121 and feed rollers 122 and 123. The said drum and feed rollers are operated continuously, with an intermittent motion, and in a synchronous relationship with the feed rollers 80 to 83.

Referring now to Figs. 2, 5 and 6, it is remembered, that shaft 89 is rotated continuously with an intermittent motion. This shaft has secured thereto gear 124, which drives gears 125 and 126, both of which gears are mounted on a common hub 127, which is rotatably supported by shaft 99. By means of the gearing, comprising the gear 128 pinned to idler shaft 129, gears 130 and 131 pinned to shaft 132, the gear 126 is effective to rotate the gear 133 and associated shaft 134, upon which is mounted the stacker drum 120 (see Fig. 1).

Pinned to the opposite end of shaft 134 is a gear, not shown, but similar in size to gear 133 and which is arranged to drive gear 135 (see Fig. 2) and its related shaft 136, upon which the feed roller 121 (Fig. 1) is mounted; thus, it is seen, that the stacker drum and associated feed roller are rotated continuously, with an intermittent motion, as long as the motor is energized, and in synchronism with the operation of the feed rollers 80 to 83, since the controlling drive shaft 89 is the common drive for both the controlling gearings. The gear ratios between gears 124 and 133 are such that one-seventh of a revolution of gear 124 will displace the drum upon which the cards are held, one cycle point.

Gear 130 also drives gear 137 and related shaft 138, upon which shaft is mounted gear 139 which drives the gearing comprising gears 140 and 141 pinned to shaft 142, gears 143 and 144, the latter gear being pinned to shaft 145. Upon the shaft 142, a feed roller 123 (Fig. 1) is mounted, and by means of a gear similar to gear 141, mounted on the shaft 142, the gear 146 and related shaft 147 are driven; feed roller 122 is mounted on shaft 147 and rotated thereby.

From the feed rollers 122 and 123 (Fig. 1), the cards are stacked in the hopper N, whereat provision is made to insure proper insertion of the cards in the stack, by providing a rubber stacker roll 148 mounted on shaft 145, which when rotated, by means of the said shaft, urges the cards to the right, as viewed in Fig. 1.

Referring now to Fig. 9, the stacker drum 120, mounted on and rotated by shaft 134, is shown to be provided with a plurality of pivoted gripping fingers 149. These fingers are urged into card gripping position by the spring pressed plungers 150. Fixed face cams 151 are provided to be suitably disposed so as to cooperate with the fingers to effect their opening and closing at the proper time. The timing of the fingers is such that the record card is gripped, after it passes the feed roller 121, and held securely to the drum as it rotates to further advance the card, and finally releasing and discharging it to the feed rollers 122 and 123.

Film sensing and recording means

With reference to Fig. 1, one of the film sensing means is shown to comprise generally, a light source comprising the individual lamps 175 supported in suitable enclosures, generally indicated 176, from one side of which individual light conducting quartz rods 177 are provided, and which are supported by the frame member 184. Mounted in the same plane as member 184 is another member 178 for supporting the quartz rods 182 extending to individual light responsive means 183, such as photocells. The said members 178 and 184 are provided with a small gap between them through which the photographic film 180 is fed. In the instant application, the film is fed intermittently to, and from the sensing station, by means to be described later herein, so that the index point positions of the film are presented successively thereto.

Referring to Fig. 8, a facsimile of a portion of the film record 180 is shown wherein the index points 181 are shown differentially disposed in various index point positions in the columnar areas. The quartz rods 177 and 182 are spaced in the respective members 184 and 178 so that they correspond to the individual columnar areas in position.

The method of sensing the data representations on the photographic film record will now be understood, assuming that the index points, representing the data representations, in the form of control spots are presented, intermittently, and successively to the sensing position or station, and that the individual light sources 175 are continuously energized, it is seen that, when no control spots appear at the particular index point positions analyzed, the light conducted from the light source to the film record by the one group of quartz rods is permitted to permeate the film, and be conducted by the other group of quartz rods to the related photo-cells, thereby conditioning the photo-cells, in a predetermined manner. However, whenever control spots appear at the sensing position, the corresponding beams of light conducted thereto are modified or blocked off, so that the light no longer is conducted to, and impinged upon, the related photo-cells, thereby controlling the action or operation of the photo-cells. It is obvious, since the said control spots disposed on the film record in different index point positions, and since the index point positions are analyzed successively, that the different beams of light are modified at differential times for controlling the operation of the related light responsive means.

The method of recording the data representation in the form of differentially positioned control spots is now evident, since the only requirement necessary for this operation is for the light sources to be normally deenergized. Now, as the film record is fed to the sensing station intermittently, the individual light sources are controlled so as to be energized at different times, thus permitting the beams of light to be conducted and directed, by the quartz rods 177, to the corresponding columnar areas thereby effecting recording upon the light sensitive photographic film, at different positions, in the said columnar areas corresponding to the timed intervals at which the related light sources are energized. In addition thereto, another film

sensing station is provided, comprising an elongated light source 186 disposed in a suitable housing 187, which may be an integral part of the member 184, and a plurality of individual light conducting elements 188, such as quartz rods similar to the rods 177, which are disposed in the member 184. Correspondingly positioned quartz rods 189 are provided in member 178 for conducting the light rays to individual photocells 190. It is seen, that the rods 188 and 189 are positioned, so that the control spots on the film record 180 are effective to modify the light rays conducted to photocells 190, before the said spots are effective to modify the light rays conducted to photocells 183 by the rods 177 and 182. The purpose of this arrangement is, so that the control data disposed on the film record can be sensed at the first sensing station, prior to the sensing of the amount data on the film record, at the second sensing station. To simplify the description to follow, the first sensing station for sensing the control data on the film will be termed the auxiliary film sensing station, whereas, the second sensing station for sensing the amount data will be referred to as the main film sensing station.

Film feeding means

Referring now to Figs. 1, 2 and 4, the means for feeding the photographic film from the supply reel 200 intermittently to, and from, the sensing or recording station and to the take up reel 201 comprise the following gearing, which gearing is controlled by the shaft 142, which as described hereinbefore, is rotated continuously with an intermittent motion. A gear 202, pinned to shaft 142, is arranged to drive the gear 203 rotatably mounted on shaft 204; attached to gear 203 is the single tooth ratchet 205, which is arranged to cooperate with the dog 206 pivotally mounted on the arm 207, which arm is fixed to the shaft 204. The armature 208 of magnet 209 normally, when the magnet is deenergized, is adapted to be positioned in the path of the said arm and dog, thereby presenting engagement of the dog 206 and ratchet 205. However, upon energization of the said magnet the armature is displaced sufficiently to release the dog, thereby permitting engagement of the said dog and ratchet, thus effecting rotation of shaft 204 by means of gears 202 and 203.

Secured to shaft 204 is the gear 210 engaging gear 211 which is fastened to shaft 212, upon which shaft 212 is mounted the film drive sprocket 213. Also secured to shaft 212 is a pulley 214 which, by the connecting belt 215, is adapted to rotate the shaft 216, upon which the take up reel 201 is mounted. Thus, it is seen, that the film 180 is fed to and from the sensing and recording stations, intermittently, by means of the driving sprocket 213 and the described gearing. It should be mentioned, that contacts 218 are provided, and adapted to be closed by the lever 219, whenever the film record 180 is present in the sensing unit, and are arranged to be opened whenever the film record supply is exhausted.

Certain circuit controlling elements are provided, which will now be described, and which must be operated, in synchronism with the feeding of the film, but are shown operated with a uniform motion instead of an intermittent motion, therefore, the following controlling and gearing means is provided. Referring particularly to Fig. 4, it is seen, that the continuously rotated gear 28 has secured thereto, an additional single tooth ratchet 220, which is arranged to cooperate with a dog 221 pivotally mounted on the arm 222, which arm is secured to a gear 223 rotatably mounted on shaft 34. Normally the dog and ratchet are maintained disengaged, by means of the armature 224 of magnet 225, in a manner similarly as described hereinabove with reference to the same type of clutch. Upon energization of the magnet, the armature 224 releases the dog 221 to engage the ratchet 220, thus effecting rotation of gear 223 and the gear 226 engaged thereby (Fig. 2). Gear 226 is secured to shaft 227, which carries the series of cams 228, for controlling the associated contacts F (see circuit diagrams).

Stepping relay means

Referring now to Fig. 11, one suitable type of stepping relay means SR is shown to comprise an advancing magnet MA, and a resetting magnet MR. Secured to the armature 163, of the advancing magnet, is an elongated pawl 164 cooperating with the ratchet wheel 165, which is freely mounted on the stud 166. Upon energization of the advancing magnet MA, the pawl is positioned to the next adjacent tooth of the ratchet, so that, upon deenergization thereof, the ratchet wheel is advanced, or partially rotated, to the left, as viewed in Fig. 11, by means of pawl 164 and the spring 167. A suitable conducting arm SA is provided, which is secured to the suitably insulated member 168, which in turn is fixed to the ratchet wheel. Thus, it is seen, that upon advancement of the ratchet wheel, the arm SA is advanced to engage the next contact of the group of contacts CT. To reset the arm SA to the normal position shown, namely, in a position so that the arm engages the first contact of the group of contacts CT, magnet MR is energized to attract its armature 169, thus displacing the extension 170 of the armature from the ratchet 165 (which normally acts as a locking pawl) sufficiently, to engage the pawl 164, and dispose it from the ratchet, so as to free the ratchet wheel, thereby permitting the arm SA and ratchet 165 to be returned to the normal setting shown, by means of the spring 171.

It is understood, that any number of contacts CT can be provided to be engaged successively by the stepping arm SA. For example, when the stepping relay means is used as a data storage device ten digital contacts are provided as shown in Figs. 12*c* and 12*d* for the relays indicated SR1*u* to SR4*u*, SR1*t* to SR4*t*, SR8 to SR11.

In certain instances, it is desired to energize the reset magnet upon reception of an advance impulse, when the stepping arm SA engages the last contact in the group of contacts CT. In such cases, provision of control contacts TC is made. Whenever the arm SA is first advanced, from the normal position as shown, a double armed member 172 is provided to follow the advancement of the said arm. The said member is loosely mounted on the stud 166, and normally is held in the position shown, by means of the member 168 to which the arm SA is secured. However, upon advancement of arm SA and member 168, the spring 173 is effective to advance the member 172, so that the longer arm of the member 172 is moved out of engagement with the spring pressed latch 174, permitting the said latch to rest upon one of the spring blades of the contacts TC. The contacts TC are disposed so that, when the arm SA engages the last contact of the group of contacts CT and, when the advance

magnet MA is operated to advance the arm SA farther to the left, as viewed in Fig. 11, the member 168 is effective to engage one of the spring blades of contacts TC, to close the said contacts, and permit the latch 174 to lock the contacts TC in the operated position. During the description of the circuit diagram, it will be pointed out, how a control circuit to the reset magnet MR may be controlled, by the latched contacts TC, to effect resetting of the stepping arm SA and member 168 to the normal position shown in Fig. 11. Upon resetting of the said arm and member, member 172 is restored to normal position, as shown, to restore the latch 174, thereby permitting the contacts TC to be opened.

Operation of machine

A—Film recording and checking.—Referring now to the circuit diagrams, particularly Figs. 12*a*, 12*b* and 12*e* (aligned in the order named), and the operation of the data reproducing machine will be described. The description to be given first will relate to sensing the perforated card, and reproducing the data representations sensed upon an unrecorded photographic film record, in the form of differentially positioned control spots. To effect this type of data reproduction, the machine must be conditioned accordingly, therefore, let it be assumed, that the main switch MS is closed, that the control switches S are positioned in the CF positions as shown, that perforated record cards are provided in the supply hopper M, that the unrecorded photographic film 180 is properly inserted in the machine, and that the start key is depressed to close the associated contacts SK2.

A circuit is then completed from conductor 250, to coils of relays R1, R2, contacts SK2, R9*b*, and contacts SK3 of the stop key to the conductor 251, causing the said relays to be energized. Upon energization of relay R1, the contacts R1*a* are closed to complete a circuit, from the power supply source to the drive motor 21, thereby effecting operation thereof, to drive the associated gearing described hereinabove. Upon energization of relay R2, a holding circuit therefor is established, by the associated contacts R2*b* now closed, through the normally closed cam operated contacts C2. The contacts R2*a* are also closed, upon energization of relay R2, to effect energization of card feed control magnet 20, by the circuit completed by the said contacts which is as follows: conductor 250, coils of magnet 20, switch S1, contacts R30*a*, R2*a* and the normally closed cam operated contacts C1 to conductor 251.

Upon energization of magnet 20, the shaft 34 is rotated to operate the card picker mechanism, thereby effecting the feeding of a card to the feed rollers 80 and 81. The gearing driving the feed rollers is also operated, when magnet 20 is energized, and shaft 34 is operated. Thus, the record card is fed, intermittently, up to the card perforating station, and thereby causes the contacts 110 to be closed. A circuit is then completed, during this machine cycle, from the power supply conductors 250 and 251 to the coil of relay, R3, energizing said relay and causing the contacts associated with this relay to be operated. The P2 cam contacts are closed, at the time the contacts 110 are operated, thus, a circuit is established from conductor 250 to the coil of relay R14, contacts R3*e*, switch S4, and contacts P2 to conductor 251, energizing the said relay. A holding circuit for this relay is completed, upon closure of the associated contacts R14*c*, through the switch S5 and cam contacts P3, which are closed at the time contacts 110 are closed, and are maintained in this condition the remaining part of the machine cycle (see timing chart, Fig. 10). This condition occurs near the end of each machine cycle, so it is understood, that relay R14 is energized near the end of each machine cycle, and maintained so, until after the beginning of the following machine cycle.

The purpose of the circuit arrangement (shown in Fig. 12*a*) is to cause operation of the relays R3, R4, R7, R8, and R14, so that the contacts R3*c*, R4*a*, R7*a*, R8*a*, and R14*a*, which are connected in series with the contacts R2*b*, are all closed at one time in the cycle, and thus provide a bridge circuit for the circuit, including the cam contacts C2 (which are opened near the end of each machine cycle), so that relays R1 and R2 are maintained energized, thus providing continuous operation of the machine.

However, when first starting the machine, it will be necessary to hold the starting key depressed, for several machine cycles, until all the control circuits are properly conditioned for continuous operation. This is obvious, since at the end of the first machine cycle, the first card is just approaching the card perforating station. This being the case, it is seen, that contacts 119 at the card sensing station are still open, thus preventing operation of relay R4, and thus preventing continuous operation of the machine at this point.

Assume, that the start key is kept depressed, so that another machine cycle is completed, the feed rollers 82 and 83 are then effective to feed the first card up to the sensing station, past the card lever 118 sufficiently to close the contacts 119, but not under the sensing brushes as yet. The sensing operation of the first card occurs during the third machine cycle. Now, at the end of the second cycle, the following circuits are conditioned: relays R3 and R4 are energized since contacts 110 and 119, respectively, are closed. Relays R7 and R8 are energized, since contacts 54 and 218 respectively are closed, these contacts are controlled by the supply of cards in the hopper M, and the film record 180 in the machine.

It is seen now, that at the time in the second machine cycle, the cam contacts C2 are opened, that cam contacts P3 are closed. It was mentioned hereinabove, that shortly before contacts P3 are closed, that cam contacts P2 are operated to energize the relay R14, thus closing the associated contacts R14*c* at this time in the cycle, so that a holding circuit therethrough is established for the said relay, by means of the operated contacts P3; and as mentioned before, this holding circuit is maintained for the remaining part of the said cycle, and during the beginning of the following machine cycle. Thus, it is seen, that from now on during each machine cycle, a circuit is completed from conductor 250 to coil of relays R1 and R2, contacts R2*b*, R8*a*, R7*a*, R3*c*, R4*a*, R14*a*, switch S3, contacts R9*b* and normally closed contacts SK3 of the stop key to conductor 251. This circuit is completed at a time in the cycle, when cam contacts C2 are opened, thus the relays R1 and R2 are maintained energized for the beginning of each following machine cycle. Also, near the end of each machine cycle, the cam contacts C1 are closed, and maintained so until after the beginning of the following cycle, so that the magnet 20 is energized, at the end of each cycle, thus effecting a

card feeding operation for each machine cycle. The machine is now conditioned for continuous operation, and at the beginning of the third cycle, the card sensing operations are effected. Therefore, it is evident at this time, that it will be necessary to render the film feeding mechanism operative, so that the film is positioned, intermittently, in synchronism with the progression of the record card. This is effected as follows:

Near the end of each machine cycle, the cam contacts C3 are closed, therefore, a circuit is completed from conductor 250 to the coil of relay R5 to contacts R3*d*, and cam contacts C3 to conductor 251 energizing said relay; at the same time, a circuit is completed from conductor 250 to the coil of relay R6, contacts R4*b*, R14*b*, and cam contacts C3 to conductor 251, energizing this relay. These circuits are maintained, for the remaining part of the said cycle, and during the beginning of the following cycle, by means of cam contacts C3. Before these said cam contacts are opened, during the said following cycle, contacts P1 are closed to maintain the relays R5 and R6 energized, through the associated contacts R5*a* and R6*b* respectively, all during the sensing and recording portions of each cycle. Contacts R5*b*, R5*c*, R5*d* and R6*a*, R6*c*, R6*d* to R6*f* associated with said relays are therefore operated, at all times, during the sensing and recording portions of the machine cycles.

Closure of contacts R6*a* completes a circuit as follows, near the end of each cycle, from conductor 250 to coils of magnets 209 and 225, contacts R6*a*, switch S2, contacts R12*a*, R2*a*, and cam contacts C1 to conductor 251, energizing said magnets. Energization of magnet 209, permits the film feeding mechanism, described hereinabove, to become effective to feed the film record 180, intermittently, to its sensing and recording station, in timed relationship, with the feeding of the record cards 52 past the sensing station therefor. Energization of magnet 225 is effective to render the control shaft 227 operative to control the timing of the F cam contacts which are controlled by cams 228 mounted thereon, the purpose of which will be described later.

The machine is now conditioned to sense the first card and all cards following thereafter successively, for controlling the film recording mechanism. It is now seen, as the individual record cards are fed past the record sensing station, the data representations represented, by the differentially positioned perforations thereon, are sensed, by means of the sensing brushes 116 cooperating with the common conducting roller 117, to complete the following circuits, at different times, depending upon whether or not perforations in the various columnar areas are presented thereto: from conductor 250 to contacts R21*b*, switch S26, conductor 252, individual light sources 175, conductors 253, sensing brushes 116, conducting roller 117, conductor 254, cam contacts P15, which are closed during the sensing portion of the machine cycle, contacts R6*f* now closed, contacts 57, which are closed during each card index point position (see Fig. 10), to conductor 251, energizing the said individual light sources, in accordance with the perforations sensed on the record cards. Obviously, as many columnar positions can be sensed on the record cards, as desired, for controlling corresponding individual light sources, for reproducing all the sensed data representations on the photographic film record.

It was mentioned hereinabove, that upon energization of the film feed control magnets 209, the photographic film record 180 is fed, intermittently, to the recording station in synchronism with the intermittent feeding of the record card to the card sensing station, so that, for example, when the "9" index point positions on the card are presented for sensing thereof, the film record is fed to its recording station, so that the "9" index point position thereof of the individual frame, or portion, of the film record is presented at the film recording station. Therefore, at the particular timed intervals the light sources are energized, by means of the card sensing circuits, the light sensitive record is exposed to the light rays, at such intervals, to effect recording thereon, in the form of control spots, as indicated in Fig. 8, at differential positions, in accordance with the data sensed. Further explanation of this form of sensing the record cards, and recording the data in the form of control spots on the film record is deemed unnecessary in order to comprehend fully, the scope of the instant invention, with this exception, that provision is also made, whereby additional data, in addition to the sensed data, may be recorded in various columnar areas on the film record, as desired, by means of manually controlled data storing devices. These devices are represented generally, by the reference character 255 in Fig. 12*e* and each comprise a common conducting ring, 256, and individual conducting segments 257, which are connected as desired, by means of the cooperating brushes 258. The brushes are positioned manually to represent any desired data, and are effective, by means of the common emitter 59, to initiate control impulses, at differential times, to correspond to the stored data for controlling, in this illustration, the individual light sources 175. Assume now, that certain orders of the said storing devices are positioned, as desired, representing predetermined data to be recorded on the film record at the same time, and in addition to, the data sensed on the record cards. It is seen, that circuits are completed, from conductors 250 and 252 to the individual lights 175, conductors 259, contacts R6*c* and R6*e* (which are closed during the sensing portion of the cycle), data storing devices 255, emitter 59, conductor 61, switch S25, contacts F14 (closed during the sensing cycle), contacts 57 and conductor 251, energizing the said light sources, whenever the rotating brushes 58 engage conducting segments 60, which are connected to the conducting segments 257, which in turn, are connected to the associated common conductor 61, by the positioned brush 58. The brush 58 of the emitter is rotated in synchronism with the card sensing operations, by means of the shaft 33, so that, during the intervals the "9" index point positions are sensed, the emitter is effective to read out the "9" position of the data storing devices, thus being effective to establish circuits for controlling the energization of the light sources, for recording the stored data upon the film record, in the form of differentially positioned control spots.

Now, in order to effect checking operations for this type of run, the perforated cards are fed through the machine, in the same order, as during the recording operations for producing the film record. After development of the film record produced, and proper positioning of it in the machine, in the original order after rewinding the film so that the individual frames are sensed at the time the corresponding cards are sensed, the start key is depressed, to effect conditioning of the machine for continuous opera-

tion, just as described. Reference should be made to Figs. 12*a*, 12*b* and 12*f* arranged in the order named, the switches remaining in the same position, as during the film recording operations, with the exception of S28, which is set in the FC position to effect continuous energization of the light sources 175. Upon conditioning the machine for continuous operation, the perforated record cards and recorded film records are fed in a timed relation past the related sensing stations. Upon sensing the perforations in the cards, the following circuits are established, at differential times, in accordance with the presentation thereof to the sensing brushes 116: conductor 250, contacts R21*b*, coils *a* of the differentially wound relays R32 and R33, brushes 116, conducting roller 117, conductor 254, contacts P15, R6*f* and 57, to conductor 251.

Sensing of the film records is effected, simultaneously with the record card sensing operations, to establish the following circuits, at differential times, whenever the control spots thereon are fed past the film sensing station. The photocells 183 are conditioned, whenever the control spots block off the rays of light therefrom, to render the associated amplifiers 260 conductive, thereby energizing the relays 261 at the said differential times. (This operation is explained more fully in the description relating to card recording which is to follow.) Upon energization of the said relays, the contacts 262 complete the circuits from conductor 250, contacts R21*b*, coils *b* of relays R32 and R33, conductors 230, contacts 262, conductor 231, contacts 57 to conductor 251. Whenever coils *a* and *b* of the relays R32 and R33 are energized at the same differential times, these relays remain unoperated, thereby indicating that the film records have been recorded, in accordance with the disposition of the perforations on the corresponding record cards. However, upon disagreement of the data sensed on the record cards and film records, it is evident, that the coils *a* and *b* of the relays R32 and R33 are not energized at the same time intervals, thereby effecting operation of these relays. Closure of contacts R32*a*, or R33*a*, completes a circuit from the power supply conductors 250 and 251 to energize relay R9, and the indicating lamp 232. A holding circuit for the said relay is then established, from conductor 250 to coil of relay R9, contacts SK4 of the non-check key, contacts R9*a* to contacts SK3 of the stop key, and the conductor 251.

The holding circuit for relays R1 and R2 is now broken, by opening of the contacts R9*b*, causing control magnets 20, 209 and 225 to be deenergized, thus interrupting further feeding of the record cards and film records. The particular non-corresponding film record can be suitably marked or identified, at this time, by the operator of the machine. To resume further feeding operations of the records, the non-check key must be depressed to open contacts SK4, before the start key is depressed to close contacts SK2, to condition the machine for further checking operations.

In the event, that during the film recording operations, data was recorded thereon in accordance with the settings of the manually positionable devices 255, this data can also be checked, by positioning the devices to represent the said data, during the checking operations. The data sensed in certain columnar areas on the film record is then compared with the data set up in the storing devices. Upon sensing the control spots on the film, the associated photocells and amplifiers are conditioned to energize the related relays 261 for establishing the following circuits, from conductor 250 to contacts R21*b*, coils *b* of relays R34 and R35, conductors 233, contacts 262, conductor 231 to contacts 57, and conductor 251. When the compared data is in agreement, the following circuits are established, at the same timed intervals, to prevent operation of the relay R34 and R35: conductor 250, contacts R21*b*, coils *a* of relay R34 and R35, contacts R5*c* and R6*e*, common conducting rings 256 of the associated data storing devices 255, brushes 258, contacts 257, segments 60 of the emitter devices 59, brush 58, conductor 61, switch S25, contacts F14, and contacts 57 to conductor 251. However, if the compared data disagree the described circuits will not be established, at the same timed intervals, so that relay R34 or R35, or both, are operated closing the associated contacts R34*a* and R35*a* to effect energization of relay R9, and the indicating lamp 232, similarly as described hereinabove with respect to contacts R32*a* and R33*a*. Further operations of the machine are then prevented, until the non-check key is depressed to open the contacts SK4, breaking the holding circuit established for relay R9.

B—Card reproducing and checking.—In view of the detailed description just set forth, and since the driving mechanism, feeding mechanisms, and control circuits are operated, and conditioned in the same manner, for reproducing the data sensed upon recorded film records on the blank record cards in the form of perforations, the following brief description is believed to be sufficient. For this description reference should be made to the circuit diagrams shown in Figs. 12*a*, 12*b*, 12*c*, 12*d* and 12*g*, and arranged in the order named. Assume now, that all the control switches S are positioned in the FC position, that switches D1, D2 and D8 are set in the A position, and that the start key is depressed to close the contacts SK2, long enough to condition the machine for automatic operation. It will be understood, for this type of operation, whereby the recorded film record is sensed, and the sensed data is reproduced or perforated on the blank record cards accordingly, that upon feeding the film record the record cards must be presented at that time at the punching station. As it will be seen from the description to follow, the film record must be properly positioned in the machine, and two blank frames thereof are fed to the film sensing station upon starting the machine in operation; of course, it will be evident too, that in the event this is not done, no harmful results are effected with respect to the instant invention, the suggestion is made merely as a practical expedient.

Upon depression of the start key, the relays R1 and R2 are energized, causing operation of the driving motor 21, and associated gearing, by means of operated contacts R1*a*; and energization of the control magnets 209 and 225, by means of contacts R2*a*, causing operation of the film feeding mechanism and the F cam shaft, as described hereinabove. At this time, cam contacts C5 are closed to energize relay R24 and to establish a holding circuit, therefor, through the closed contacts R24*c* and cam contacts F8. Thus, it is seen, that upon depression of the start key, the card feed magnet 20 is energized by the following circuit, from conductor 250 to coils of magnet 20, contacts R24*a*, normally closed contacts R3*b*, switch S2, contacts R12*a*, R2*a* and contacts C1 to conductor 251, thereby effecting

a card feeding operation. Near the end of the first machine cycle, the contacts 110 are operated by the card fed therepast to energize relay R3, and cause the contacts R3*a* to be closed, thus opening the circuit to the feed control magnet 20 for the following machine cycle. This is effected, since contacts R23*a* are not closed until near the end of the said following cycle, when cam contacts F6 are closed to establish a circuit from conductor 250 to coil of relay R23, contacts R24*b* and R3*f*, and contacts F6 to conductor 251, energizing said relay, and establish a holding circuit therefor, through contacts R23*c* and cam contacts F7. Therefore, at the beginning of the third machine cycle, the magnet 20 is again energized through a circuit from conductor 250 to coil of magnet 20, contacts R23*a*, contacts R3*a*, switch S2, contacts R12*a*, R2*a*, and cam contacts C1 to conductor 251, whereby card feeding operations are effected, and by means of the feed rollers 80 and 81 the first card is now fed, intermittently, past the perforating station.

Upon properly conditioning the machine with record cards, and a control film record, the contacts 54 and 218, respectively, are operated to energize relays R7 and R8, respectively. Thus, it is seen that a holding circuit, bridging the holding circuit including contacts C2, is established for relays R1 and R2, by the series circuit arrangement of contacts R2*b*, R7*b*, R8*b*, R23*b*, switch S3, contacts R9*b* and SK3, thus establishing continuous operation of the machine. It should also be mentioned, that relay R5 is energized, at the beginning of each cycle, by means of the cam contacts C3, through the contacts R3*d* to establish a holding circuit through the contacts R5*a* and cam contacts P1, which is maintained throughout the entire sensing portion of the cycle, thus maintaining contacts R5*b* to R5*d* closed during the said sensing cycle.

It should be understood now, that as the different index point positions are advanced to the punching station, the corresponding index point positions on the film record are sensed, for example, as the "9" index point position on the film record is sensed, the "9" index point positions of the record cards are at the punching station under the perforating plungers. As the differentially positioned control spots on the film record are introduced at the sensing position, the presence of the control spots is effective to modulate or interrupt the impingement of the light rays from the light sources upon the related photocells. It is seen, that, by means of switches S27 and S28, all the individual light sources are energized continuously. Whenever no control spots are present at the sensing station, the light rays are conducted by the quartz rods 177 and 182 therefrom through the transparency of the film record to the related photo-cells, thus conditioning the said cells. These light responsive means 183 are connected to any well known type of amplifiers, generally indicated at 260, which in turn are connected to control relays 261. The amplifiers are adjusted, so that, when light impinges upon the light responsive means, no current flows in the output circuit thereof, however, when the light rays are interrupted, by the presence of control spots on the film record, the light responsive means and amplifier are conditioned, so as to permit current to flow in the output circuit of the amplifier units, this is a well known expedient in the art and needs no further explanation.

It is understood now, that upon the presence of a control spot at the film sensing station, the corresponding light responsive means and amplifying means are conditioned, so as to effect energization of the related relays 261 when they, by means of the associated contacts 262, complete circuits through the punch control magnets 66 as follows: from conductor 250 to contacts R21*b*, switch S26, punch magnets 66, contacts 262, common conductor 231, contacts 57 to conductor 251, energizing the corresponding punch magnets 66. Energization of the said magnets operate the related punch plungers to effect perforation of the record card, at the particular columnar index point positions, corresponding to the index point positions in which the sensed control spots appeared on the film record. Further detailed description is believed unnecessary, possibly with the exception, that the manually set devices 255 may be used to effect perforating of additional data on the record card, in addition to the data sensed on the film record. The desired data stored in the devices is read out, at differential times, by the emitter 59, to complete additional circuits to the punch magnets as follows, from conductor 250 to contacts R21b, switch S26, selected punch magnets 66, conductor 234, contacts R5*b* to R5*d* (closed during the sensing cycle) hand set devices 255, emitter 59, conductor 61, switch S25, cam contacts P14 and contacts 57 to conductor 251, thus energizing the selected punch magnets, at differential times, corresponding to the data stored in the hand set devices, thereby effecting perforation of the record card in accordance with this data, in addition to the sensed data disposed on the film record.

Provision is made in the machine, whereby the card checking operations can be effected during the card reproducing operations and are effected one cycle later. The data sensed on the film record, not only controls the punching magnets, but simultaneously therewith controls the operations of data storing devices to store the said data, which is then compared with the data punched on the card in the previous cycle. The following circuits which are conditioned during various machine cycles for effecting these operations will now be described. It is to be understood, that these circuits which are to be described are established during the card recording operations, during which the circuits just set forth were established. During the first cycle of operation, upon starting up the machine, relay R18 is energized at the beginning of the cycle, by means of the circuit from conductor 250, coil of said relay, contacts R29*a*, switches D3 and D2 to contacts P4 (see Fig. 10) and conductor 251. A holding circuit is established from conductor 250 to coil of relay R18, contacts R18*a* and R19*a* to conductor 251. Later in this cycle R29 is energized, by a circuit from conductor 250 to coil of said relay, contacts R18*b* and P11 to conductor 251. Two holding circuits for this relay are provided, one through contacts R29*c* and R18*c*, and the other through contacts R29*c* and P12. After the energization of relay R18, provision is made for resetting the data storing relays SR8 and SR9 to a normal position, near the end of the cycle, by a circuit from conductor 250 to reset magnets MR8 and MR9, contacts R18*d*, conductor 235, switch D8 (in position A), switch D9, conductor 236, switch D5 and contacts P7 to conductor 251, energizing said reset magnets, to restore the associated conducting arms to the normal position indicated in Fig. 12*d*.

Now, at the beginning of the third cycle, when

the film records and cards are fed simultaneously, and in timed relation, to the associated sensing and recording stations, relay R19 is energized as follows: conductor 250, coil of relay R19, contacts R29b, switches D3 and D2, and contacts P4 to conductor 251. Energization of the said relay causes contacts R19a to open, breaking the holding circuit for relay R18 at this time. Due to deenergization of relay R18, relay R29 is deenergized, when the contacts P12 open, which occurs shortly after the beginning of the cycle. It was described how, during this cycle, the punch magnets 66 are energized to effect recording upon the cards, due to the closure of contacts 262 at differential times.

Circuits are also completed, upon closure of the said contacts 262, for causing the data sensed upon the film records to be stored in the relays SR8 and SR9, which are as follows: conductor 250, contacts R21b, coils *a* of relays R36 and R37, conductors 237, contacts 262, conductor 231 and contacts 57 to conductor 251, energizing said relays, at the timed intervals the control spots on the film records are sensed. Holding circuits for the said relays are established through the associated contacts R36b and R37b, and contacts C12. Closure of contacts R36a and R37a complete circuits from conductor 251 and contacts 162 to the advancing magnets MA8 and MA9 through the contacts R18f and R18h, respectively. The said advancing magnets are then energized, successively, by the impulses initiated by contacts 162, to advance the conducting arms of relays SR8 and SR9 to represent the data therein, which is sensed on the film record and reproduced on the related card.

After perforation of the record cards, they are advanced to the main sensing station, whereupon contacts 119 are closed to energize relay R4. Relay R6 is then energized, by a circuit from conductor 250 to coil of said relay, contacts R4b, R14b and contacts C3 to conductor 251. A holding circuit is established for this relay through contacts R6b and contacts P1, maintaining the relay R6 energized for almost a complete machine cycle (see timing chart). At this time, resetting of the data storing relays SR10 and SR11 is also effected by the following circuit: conductor 250, magnets MR10 and MR11, contacts R18e, conductor 235, switches D8 and D9, conductor 236, switch D5 and contacts P7 to conductor 251. Two sets of data storing relays are provided, so that, when entry of the data is effected in one group, comparison of the data set up in the other group can be made with the data punched on the record cards.

Now, that the card is punched in accordance with the data sensed on the corresponding film record, not only must this data be checked with the data stored in relays SR8 and SR9, but provision must be made to store the data of the following film record in relays SR10 and SR11. The comparing circuits are as follows: The perforated card is sensed by brushes 116 to complete circuits, at differential times, extending from conductor 250, contacts R21b, coils *a* of relays R32 and R33, brushes 116, conducting roller 117, conductor 254, contacts P15, R6f and 57 to conductor 251. Simultaneously therewith, if the data is in agreement, circuits are completed from conductor 250, contacts R21b, coils *b* of relays R32 and R33, conductors 239, contacts R6g and R6h, contacts R18j and R18l respectively (relay R18 is energized during this cycle through contacts R29a, switches D3 and D2 and contacts P4), conductors 240, contacts CT8 and CT9, contacts 60a of emitter 59a, brush 58a, switch S25, contacts P14, conductor 196, contacts 57 and conductor 251. As long as the compared data agree, the said relays R32 and R33 are not operated, but upon disagreement of the data, one or both of said relays are operated to close the contacts R32a and/or R33a, effecting energization of relay R9 and the associated indicator lamp 232. Record feeding operations are then interrupted, due to opening of contacts R9b, and this condition is maintained until the non-check key operated contacts SK4 are opened, and further continuous machine operations established in the manner described hereinabove.

The circuits for storing the data, sensed on the following film record, in relays SR10 and SR11 are as follows: conductor 250 to advancing magnets MA10 and MA11, contacts R18g and R18i respectively, contacts R36a and R37a, and contacts 162 to conductor 251. The impulses initiated, by contacts 162, cause the associated conducting arms to be advanced, upon the successive energization of the coils Ma10 and Ma11, to enter the data in these relays, in accordance with the sensed data on the film record. It is remembered, that the contacts 262 are closed at the differential times the control spots on the film records are sensed to energize the punch magnets 66, and the relays R36 and R37. Upon completion of the described operations, the relays SR8 and SR9 are reset, for further entry of data therein, and at that time, the data stored in relays SR10 and SR11 is compared with the data sensed by the card brushes 116, similarly as just described with respect to relays SR8 and SR9.

C—Film recording with class selection, elimination field selection and checking operations.— Referring now to Figs. 12a, 12b and 12h arranged in the order named, the description will be given of the operations to effect reproducing of data upon an unrecorded photographic film record, in accordance with the data sensed on a perforated card, including class selection operations, whereby the data sensed in one field of the perforated cards is reproduced in any predetermined field on the photographic film record. These operations are effected, by comparing certain class data on the record cards with predetermined data stored in suitable manually settable devices, and in the event the compared data agree, certain selected amount data disposed in a particular field on the record card is recorded in a different field on the film record, than it normally would be recorded, if the compared data was found not to correspond.

Assume the machine to be conditioned for film recording operations, that is, the control switches S are positioned in the CF positions as shown, and that the start key is depressed to close contacts SK2, for conditioning the control circuits, so that the machine is controlled for automatic and continuous operations. These specific control circuits have been traced in detail, in section A, hereinabove, therefore, it is not deemed necessary to repeat such description at this time.

Since, the machine is now conditioned for continuous and automatic operation, the record cards are fed successively, and intermittently, past the card sensing stations for controlling the film recording mechanism. Assume now, that the brushes 258 of the manually settable devices 255, of which four are shown in Fig.

12*h*, and designated A, B, C, and D, are set to represent certain predetermined data, assume further, that the number, represented by devices A and B, is compared with the sensed class data for controlling class selection operations, and the number, represented by devices C and D, is compared with the class data for controlling card elimination operations.

The class data is sensed at the first, or auxiliary sensing station by the brushes **112**, and assuming, that certain of the sensed class data corresponds to the data set up in the settable devices A and B, it is seen, that the following circuits are established: conductor **250**, emitter device **59***b*, settable devices A and B, pick-up coils *a* of relays R38 and R39, conductors **252**, brushes **112**, conducting plate **113**, contacts R3*i*, P16 and **154** (see Fig. 10) to conductor **251**, thus energizing relays R38 and R39. Holding circuits are established for the said relays, from conductor **250** to the holding coils *b* of the relays, contacts R38*b*, and R39*b* respectively, switch S32 and contacts P17 to conductor **251**. The described holding circuits are maintained during the entire sensing portion of the cycle, by means of the said cam controlled contacts. It should be mentioned, that in the instant application, the emitter device **59***b* is arranged so that the brush **58***b* thereof engages the individual conducting segments **60***b* successively, and at the same instances, that the corresponding index point positions on the card are positioned past the sensing brushes **112** at the auxiliary sensing station.

Near the end of the cycle, during which relays R38 and R39 are energized, cam contacts P2 are closed (see Fig. 10) to complete a circuit from conductor **250** to coil of relay R11, contacts R38*a*, R39*a*, switch S4, and contacts P2 to conductor **251**, energizing relay R11. A holding circuit is then established, from conductor **250** to coil of relay R11, contacts R11*a*, switch S5 and contacts P3 to conductor **251** which is maintained until the following cycle. At the beginning of the said following cycle, due to energization of relay R11, the relay R20 is energized, by means of the circuit established from conductor **250**, to coil of relay R20, contacts R11*b*, switch S9 and contacts P4 to conductor **251**. The holding circuit for this relay is as follows: conductor **250**, coil of relay R20, contacts R20*b*, switches D4, S11, and contacts P5 to conductor **251** which is maintained until near the end of this cycle by the cam contacts P5.

Energization of relay R20 causes the associated contacts R20*c* and R20*e* to be closed, and contacts R20*d* and R20*f* to be opened, and in this manner, connecting the corresponding light sources **175** to the sensing brushes **116** for the particular fields on the photographic film record in which recording is to be effected of the control spots, representing the amount data sensed on the record card, of which the class data thereon corresponded to the preset data in devices A and B.

It is understood, that the film record **180** is fed in synchronism with record cards, so that, for example, when the "9" index point positions on the cards are presented to the sensing brushes **115**, the film record is presented to the recording station, so that the "9" index point positions of the individual frames, or portions, of the film record are presented to the recording position, namely, the position whereat the quartz rods **177** are disposed. Therefore, at the particular timed intervals the individual light sources **175** are energized, by means of the established card sensing circuits, the photographic film record is exposed to the light rays, at such intervals, to effect recording thereon, in the form of control spots as indicated in Fig. 8, at differential positions in accordance with the data sensed.

It is evident now, the amount data disposed on the card, the class data of which corresponds to the preset data in set-up devices A and B, is sensed by the brushes **116**, to complete the following circuits, at differential times, in accordance with the value of the sensed data perforations: conductor **250**, contacts R21*b*, switch S26, the light sources **175** connected to contacts R20*c* and R20*e*, conductors **253**, sensing brushes **116**, conducting roller **117**, contacts P15, R6*f* and **57** to conductor **251**, energizing said light sources, at the same instances, that the perforations in the record card are sensed, thus recording the sensed data representations upon the film record, in the form of control spots in the particular columns, or fields, thereon corresponding to the energized light sources. Whenever the compared data correspond, relay R20 is energized, thereby effecting recording upon the film record in the fields thereon controlled by the light sources connected to contacts R20*c* and R20*e*. However, when the compared data does not correspond, both relays R38 and R39 are not energized, during the same cycle, and thereby energization of relay R20 is not effected, thus causing the light sources **175** connected to contacts R20*d* and R20*f* to be energized, when the perforations on the card are sensed for recording the control spots in the columns, or fields, associated with the last mentioned light sources.

In the manner just described, the amount data on a record card, when sensed, can be recorded in different fields on the photographic film record, depending upon whether or not the class data on the said record card corresponds to the data set up in the manually settable devices, the value of the class data determining the particular field in which the recording is effected.

When it is desired to eliminate the recording of the data in certain record cards upon the film record, the contacts R21*b*, which are included in the circuits for the light sources **175**, are opened during the sensing of said cards, so that, upon sensing the perforations by brushes **116**, circuits to the light sources cannot be completed. Assume, therefore, that it is desirous to eliminate recording upon the film record, the data on the cards which have class data corresponding to the present data. For these assumed conditions, it is seen upon sensing the class data, that the following circuits are established: conductor **250**, emitter device **59***b*, manually settable devices C and D, pick-up coils *a* of relays R40 and R41, conductors **254**, brushes **112**, plate **113**, contacts R3*i*, P16 and **154** to conductor **251**, energizing the said relays. The holding circuits for said relays are from conductor **250** to the holding coils *b*, contacts R40*b*, and R41*b*, respectively, switch S32 and contacts P17 to conductor **251**. During the cycle the said class data is sensed, relay R12 is energized, by means of the circuit, from conductor **250** to coil of relay R12, contacts R40*a* and R41*a*, switch S4, and contacts P2 to conductor **251**. The holding circuit for this relay is as follows: conductor **250**, coil of relay R12, contacts R12*b*, switch S5 and contacts P3 to conductor **251**, which is maintained for the following cycle. During the said following cycle relay

R21 is energized as follows: conductor 250, coil of relay R21, contacts R12c, switch S9, and contacts P4, to conductor 251. This last mentioned relay is maintained energized most of the cycle, by the holding circuit from conductor 250 to coil of relay R21, contacts R21a, switch S11 and contacts P5 to conductor 251. As mentioned before, energization of relay R21 causes the contacts R21b to open, thus preventing energization of the light sources 175, and thereby eliminating any recording upon the film record of the data on the record cards, which have class data disposed thereon corresponding to the data set up in the settable devices C and D.

Film feeding operations are also suspended as long as relay R12 remains energized. This condition is effected, by deenergizing the film feeding control magnet 209, by opening the normally closed contacts R12a associated with, and controlled by, the coil of relay R12.

For card field selection operations, refer to Figs. 12a, 12b, and 12j (arranged in the order named), and assume that it is desired to record upon the film record, in the same fields the data sensed in different fields, upon the record cards, the sensing of the particular fields depending upon whether or not the class data sensed corresponds to the data set up in the manually settable devices. Upon correspondence of the compared data, relay R20 is energized for the entire sensing portions of the cycle, similarly as described in detail hereinabove, for this reason, repetition of the detailed description of these control circuits is deemed unnecessary. Thus, it is seen, that whenever relay R20 is energized, the data sensed by the brushes 116, which are connected directly to contacts R20c and R20e, is recorded in certain columns or fields upon the film record, in the manner described hereinbefore. Whenever the relay R20 is deenergized, which condition is indicative of the fact that the compared data disagree, recording in the same said field, upon the film record is effected of the data sensed by the brushes connected to contacts R20d and R20f.

Now, in order to effect checking operations for this type of run, the perforated cards are fed through the machine in the same order as during the recording operations, just described, for producing the film record. After development of the film record produced, and proper positioning of it in the machine, so that the individual frames are sensed at the time the corresponding cards are sensed, the start key is depressed to effect conditioning of the machine for continuous operation as described. Reference should be made to Figs. 12a, 12b and 12i (arranged in the order named), the switches remaining in the same position as during the film recording operations, with the exception of S28, which is set in the FC position to effect continuous energization of the light sources 175. Upon conditioning the machine for continuous operation, the perforated record cards and recorded film records are fed in a timed relation past the related sensing stations.

The class data on the record cards is sensed, by the brushes 112 similarly as during the film recording operations, to control the operations of relays R38 and R39 during class selection, and card elimination operations, which in turn control the operation of relays R11 and R20. Therefore, it is seen, that depending upon whether or not relay R20 is energized, the data representations of the particular fields sensed on the developed film record are directed, by means of the relays 261 associated with the film record sensing means, to the coils b of relays R32 and R33. The amount data representations on the cards are sensed, by the brushes 116 of the main sensing station, and impressed on the coils a of the said relays, so that, whenever the differentially wound coils of these relays are energized at the same timed intervals, continuous machine operations are effected. However, as described fully hereinabove, in connection with the checking circuits of simple card to film reproducing, whenever the said coils are not energized, at the same timed intervals, the relays R32 and R33 are rendered operative, to effect energization of relay R9, and cause the continuous operation of the machine to be interrupted.

Whenever certain cards were eliminated during the film recording operations, this feature is checked in the same manner. As mentioned hereinabove, when certain of the class data, sensed by brushes 112, agrees with the data set up in devices C and D, relays R40 and R41 are energized to effect energization of relays R12 and R21. During the checking operations, energization of relay R21 causes contacts R21b to be opened, and disconnect the light sources 175 from the power supply, thus preventing further film sensing operations as long as relays R40 and R41 are energized. Film feeding operations are also suspended, during this time, since contacts R12a are opened to deenergize the film feeding control magnet. The circuits, including the brushes 116 of the main sensing station, are also opened, due to operation of contacts R21b, so that faulty operations of relays R32 and R33 are not effected during the checking of card elimination operations.

Regarding the checking operations, whenever card field selection operations are effected during the film recording operation, reference should be made to Figs. 12a, 12b and 12k (arranged in the order named), and it is seen, that whenever the class data, sensed by brushes 112 of the auxiliary station, agree with the data set up in devices 255, relays R38 and R39 are energized, as described before, effecting energization of relay R20, thereby causing transferring operations with respect to the sensing of the data disposed in different fields on the record cards; that is, the brushes 116 associated with certain fields are effective to energize the coils a of relays R32 and R33, at such times, when relay R20 is deenergized, and the brushes associated with certain other fields are effective to energize the said coils when relay R20 is energized. Thus it is seen, when coils a and b of the relays R32 and R33 are energized, at the same timed intervals, in accordance with the data sensed on the cards and film records, respectively, these relays are not operated, and relay R9 remains deenergized, permitting continuous operation of the machine, whereas when the said coils are not energized, at the same differential times, relay R9 is operated to interrupt further continuous and automatic operations.

D—Card recording, class selection, elimination, field selection and checking operations.—Referring now to Figs. 12a, 12b, 12c, 12d, and 12l (arranged in the order named), a description first of card recording operations including class selection, film frame elimination, and field selection operations will be given briefly, followed by a description of the checking operations for these type of runs. Assume now, that all the control switches S are positioned in the FC position, that

switches D1, D2, and D8 are set in the A position, and that the start key is depressed to close contacts SK2 long enough to condition the machine for automatic operation. These control circuits have been traced in detail, in the description in section B hereinabove, and need not be repeated here. The description referred to, sets forth fully, how energization of the punch magnets 66 is effected to perforate the particular columnar index point positions corresponding to the index point positions in which the sensed control spots appeared on the film record.

This description, however, did not include any consideration of class selection, field selection, or film frame elimination operations. It is understood, that the auxiliary, or first, film sensing station comprising light source 186, quartz rods 188 and 189 and photocells 190, is effective to sense the class data disposed on the film record, prior to the sensing of the amount data at the main sensing station and, as will be shown, is effective to control the following operations, when connected in the circuits, as shown in the circuit diagrams referred to, in the present section.

Assume now, that class selection operations are to be effected, and that the manually settable devices A and B are set up with predetermined data, which corresponds to the class data sensed at the auxiliary sensing station. For this condition, the following circuits are established at differential times during the sensing cycle: conductor 250, emitter device 59*b*, settable devices A and B, pick-up coils *a* of relays R38 and R39, conductors 264, contacts 365 of relays 266, contacts 156 to conductor 251, energizing said relays. The relays 266 are energized, by means of the conditioned photocells 190 and associated amplifiers 267, whenever the rays of light from the source 186 are modified by the differentially positioned class control spot representations, precisely as relays R261 are energized, and described hereinbefore.

Holding circuits are established for relays R38 and R39 as follows: conductor 250, holding coils *b* of the said relays, contacts R38*b* and R39*b*, switch S32, and contacts F15 to conductor 251. Energization of the said relays is effective to energize relays R11 and R20, as described hereinabove, whereby relay R20 is maintained energized for most of the cycle following the said sensing cycle. Energization of relay R20 causes the punch control magnets 66 connected to contacts R20*c* and R20*e* to be energized, whenever the compared data agrees, to effect perforating of the record cards, in different fields, in accordance with the amount data sensed at the main film sensing station than when the compared data does not correspond.

For film frame eliminating operations, assume that the class data sensed corresponds to the data set up in settable devices C and D. For these conditions, relays R40 and R41 are energized, causing in turn relays R12 and R21 to be energized (similarly as described hereinabove), thereby causing contacts R21*b* and R12*a* to be opened during the cycle following the sensing cycle. Opening of contacts R21*b* prevents the punch control magnets 66 from being energized, and opening of contacts R12*a* suppresses further card feeding operations, due to deenergization of magnet 20, as long as the compared data corresponds.

For field selection operations, refer now to Figs. 12*a* to 12*d* and 12*m* (arranged in the order named), and assume, that the sensed class data and the data, set up in devices A and B, correspond to effect energization of relay R20, similarly as described hereinabove. For these conditions it is seen, that the punch magnets 66, connected to contacts R20*c* and R20*e*, are energized, and controlled, in accordance with the data sensed at the main film sensing station, and effective to condition the associated photocells 183, amplifiers 260 and relays R261. When the compared data does not correspond, relay R20 remains deenergized, and the same said punch magnets 66 are then energized, and controlled, in accordance with the data sensed in those fields on the film record, which are effective to condition the photocells 183, amplifiers 260 and relays R261, the contacts 262 of which are connected directly to contacts R20*d* and R20*f*. In this manner it is seen, that the same punch magnets are controlled by the data disposed in different fields on the film record, upon sensing the said data at the main film sensing station.

Provision is made in the machine, whereby the checking operations can be effected during the card reproducing operations, but one cycle later than the reproducing operations. It was described in section B hereinabove, that the data sensed on the film record, not only controls the punching magnets, but simultaneously therewith controls the operations of data, storing devices to store the said data which is then compared with the data punched in the card in the previous cycle. In view of the detailed description of certain of the checking circuits, the following brief description is deemed sufficient. For checking operations during card recording, including class selection and frame elimination operations, reference again should be made to Figs. 12*a* to 12*d* and 12*l*. It was pointed out in the description in section B, that the pairs of data storing relays SR8, SR9 and SR10, SR11 are used alternately for entering the data therein, as sensed upon the film record, and then compared with the data punched on the cards. Comparing operations are effected during the same cycle that data entry operations are effected. It was also mentioned, that at the beginning of the checking operations, the storing relays SR8 to SR11 are reset to the normal position, as shown in Fig. 12*d*, before data entry therein is effected. Assume now, that these preparatory operations have been completed, as described hereinabove, and that the film records and cards are fed simultaneously, and in timed relation, to the associated sensing and recording stations. Assume also, that the class data sensed by the auxiliary film sensing station corresponds to the data set up in the settable devices A and B.

It is understood then, that relays R38 and R39 are energized, and maintained so during the sensing cycle, by means of the holding circuit established by contacts R38*b* and R39*b*. Relays R11 and R20 are then energized, precisely as described hereinabove, causing contacts R20*c* and R20*e* to be closed. Now, upon closure of contacts 262, at differential times, in accordance with the data sensed on the film record, not only are the punch magnets 66 energized accordingly, but circuits are also completed from conductor 250 to contacts R21*b*, to pick up coils *a* of relays R36 and R37 to contacts 262, 57 and conductor 251, energizing said relays which are held up by the circuits through contacts R36*b*, R37*b* and C12. The advancing magnets Ma8 and Ma9 are then energized, successively, by the impulses initiated by contacts 162, due to the closure of contacts R36*a*

and R37*a*. In this manner, the data sensed during one cycle is stored in relays SR8 and SR9.

After perforating the card, and effecting entry of the data in the said storing relays in accordance with the data sensed, the card is advanced to the main sensing station. It should be stated, that upon energization of relay R20 in the previous cycle, closure of contacts R20*a* established a circuit from conductor 250 to coil of relay R16, contacts R20*a*, switch D1 (in A position), and contacts C4 to conductor 251, energizing said relay, which is held energized through contacts R16*a* and P3. Contacts R16*b* then close a circuit, extending from conductor 250 to coil of relay R17, contacts R16*b* and P4 to conductor 251, energizing said relay, and establishing a holding circuit through contacts R17*a* and F4. Now, whenever, during checking operations, it is determined that class selection operations are to be effected, relays R20 and R17 are energized. Relay R20 selecting the proper punch magnets, and relay R17 effecting proper selection of the sensing brushes, so that the corresponding fields which were punched are sensed in order to check the said perforations.

Comparison of the selected data is effected as described hereinabove, brushes 116 establish circuits, at differential times, through the coils *a* of relay R32 and R33, and the emitter 59*a* establishes circuits through the storing relays SR8 and SR9, at differential times, through coils *b* of relays R32 and R33. As long as the compared data agree relays R32 and R33 are not operated, however, upon disagreement of the data compared, relay R9 is energized, due to closure of either or both contacts R32*a* and R33*a*, thus interrupting further record feeding operations and continuous machine operations.

It was mentioned hereinabove, that during the said comparing operations, data entry operations are effected, simultaneously, to store the data sensed on the following film frame in relays SR10, and SR11 and perforate this data on the succeeding record card. The control circuit for this operation extends from conductor 250 to advancing magnets Ma10 and Ma11, contacts R18*g* and R18*i* respectively, contacts R36*a* and R37*a* and contacts 162 to conductor 251. The impulses, initiated by contact 162, cause the conducting arms of relay SR10 and SR11 to be advanced, upon successive energization of the said magnets, to enter the data therein, in accordance with the data sensed on the film record. Relay R20 controls the selection of the punch magnets 66 for reproducing the data on the record card, and relay R17, which is controlled simultaneously with the control of relay R20, controls the selection of the sensing brushes 116 for checking the perforations on the said record card.

For checking frame elimination operations, it should be understood now, that whenever the class data sensed on the film records by the auxiliary film sensing station agree with the preset data in devices C and D, relays R40 and R41 are effective to cause operation of relays R12 and R21. Operation of relay R21 causes the circuits to the punch magnets 66, relays R36 and R37 and relays R32, and R33 to be opened by means of contacts R21*b*. Checking operations are thus eliminated, and card feeding operations are suspended for these periods, since contacts R12*a* open the circuit to the card feed control magnet 20.

For checking field selection operations, it is seen by referring again to Figs. 12*a* to 12*d* and 12*m*, that when the class data sensed on the film records agree with the preset data in devices A and B, relays R38 and R39 are energized to control the operation of relays R11 and R20. Relay R20 controls the selection of the particular fields of the film records which are sensed and recorded upon certain fixed fields on the cards. The data stored in the storing relays SR8 to SR11 are then compared alternatively with the data sensed on the record cards to control the operation of relays R32 and R33 similarly as described hereinbefore.

E—Film recording with master card and checking operations.—Referring now to Figs. 12*a* to 12*d* and 12*n*, arranged in the order named, the description will be given of the operations to effect reproducing of data upon an unrecorded photographic film record, in accordance with the data sensed on a perforated card, including master card operations, whereby a plurality of individual film frames of the data on a card are reproduced, the number of film frames reproduced, being in accordance with the control number perforated on the card. Such operations are effected by storing the control number, and the data to be reproduced, in storage devices, and then reproducing a number of film frames, in accordance with the stored data, equivalent to the control number stored.

Assuming, that the machine is properly conditioned with cards and film records, that the control switches S are positioned in the CF positions, and that switches D3 to D7, D9 and D10 are set in the A position, the start key is depressed to close contacts SK2 long enough until continuous operation of the machine is established, as described in the sections hereinabove. Attention should be directed to the following additional control circuits, which are established during the machine cycles, and have not been referred to hereinabove.

At the beginning of each machine cycle, cam contacts P9 are closed momentarily; therefore, each machine cycle after the energization of relay R3 the following circuits are established: conductor 250, coil of relay R27, switches D7 and S20, contacts R3*g* and contacts P9 to conductor 251, energizing relay R27, and completing a holding circuit therefor, from conductor 250, coil of relay R27, contacts R27*c*, switch S21, and contacts P10 to conductor 251. Since the cam contacts P10 are closed during the entire sensing cycle, relay R27 is maintained energized all during the sensing cycle. Through the contacts R27*a* and cam contacts P2, both of which are closed near the end of the sensing cycle, a circuit is established to energize relay R13, and establish a holding circuit therefor through contacts R13*a* and contacts P3. Thus, it is seen, that relay R13 is energized near the end of each cycle, and maintained energized until the following cycle.

It was stated, that the machine is conditioned for automatic operation near the end of the second cycle, and that card sensing operations are effected at the main sensing station during the third machine cycle. It is during the last mentioned cycle that relays R30 and R31 are energized. At the beginning of each cycle, contacts P13 are closed momentarily, and due to the previously conditioned circuits the following circuits are established: conductor 250 to coil of relay R30, contacts R13*d* and contacts P13 to conductor 251, energizing the said relay to

establish a holding circuit therefor, through the contacts R30*i* and normally closed contacts R25*f*. Contacts C10 are also provided to maintain this holding circuit, at certain times, due to the closure thereof which occurs near the end of each cycle. The purpose of these contacts will be understood as the description progresses. Relay R30 will now remain energized until relay R25 is energized. Energization of relay R30 causes the circuit to the card feed control magnet to be opened, due to contacts R30*a*, thus preventing further card feeding and advancing operations until relay R25 is energized.

It is noted, that contacts R30*c* are provided to bridge the contacts R6*a* in the film feeding control magnet 209 circuit, and contacts R30*d* are provided to bridge the contacts R4*a*, R7*a*, R3*c* and R14*a* in the circuit including relays R1 and R2. The purpose of this arrangement is to insure that, upon the feeding of a last card, the data thereof is fully reproduced before causing interruption of the automatic operations.

Before continuing with the description of the energization of relay R25, the circuits which are conditioned by the control data, or numbers, sensed on the cards should be described. Assume now that the first card is just being fed past the auxiliary sensing station, and that a predetermined control number is perforated in the card, indicating that a predetermined number of individual film frames are to be produced in accordance with the amount data on the said card. Upon sensing the control data, or number (which are disposed in predetermined fields or columnar areas), at the auxiliary sensing station, the following circuits are completed: conductor 250 to pick-up coils *a* of relays R42 and R43, conductors 191, auxiliary sensing brushes 112, conducting plate 113, contacts R3*i*, P16 and 154 to conductor 251, energizing the said relays. Holding circuits are then completed which are as follows: conductor 250, holding coils *b* of relays R42 and R43, contacts R42*b* and R43*c* respectively, coil of relay R44, switch S33, and contacts P18 to conductor 251, energizing said relay. In this manner, relays R42, R43 and R44 are maintained energized for the entire sensing portion of the cycle. Energization of relay R44 causes contacts R44*a* to be closed, and establish a circuit from conductor 250 to said contacts, advancing magnets MA5*u* and MA5*t*, switch S21, and contacts P10 to conductor 251. The stepping arms SA5*u* and SA5*t* of the relays SR5*u* and SR5*t* are not advanced until the associated control magnets MA5*u* and MA5*t* are deenergized. Due to the closure of contacts R42*a* and R43*b*, at a predetermined time in the sensing cycle, a plurality of impulses are now impressed upon the advancing magnets MA1*u* and MA1*t* to energize the said magnets, a number of times, corresponding to the control numbers sensed on the said card at the auxiliary sensing station, thus entering the control data, or number, into the data storing devices, represented by the relays SR1*u* and SR1*t*. The control circuits for the said advancing magnets are as follows: conductor 250, coils of magnets MA1*u* and MA1*t*, contacts 1 of the group CT5*u* and CT5*t*, contacts R42*a* and R43*b*, switch S18, and contacts 158 to conductor 251. In this manner, the control number of the first card is entered in the storing devices SR1*u* and SR1*t* referred to.

Due to the spacing of the auxiliary and main sensing stations, and the difference in the timing of the sensing operations at these stations (see Fig. 10), it is necessary to provide a plurality of storing devices for storing the different control numbers disposed on the different cards, which are fed successively to the stations. It is sufficient to mention, that during the sensing of the second card at the auxiliary sensing station, sensing of the first card at the main sensing station is being effected. After the first card at the auxiliary station is sensed, the contacts P18 open to break the holding circuit for relays R42 and R43, and causing deenergization of magnets MA5*u* and MA5*t*, thus advancing the associated stepping arms SA5*u* and SA5*t* to the second contacts of the group CT5*u* and CT5*t*, respectively. In this manner, a second group of storing devices, namely, SR2*u* and SR2*t*, are selected for storing the control data of the second card.

During the sensing of the second card at the auxiliary sensing station, whenever the control perforations are sensed, circuits are completed through the brushes 112 to energize the pick-up coils *a* of relays R42 and R43, at predetermined times corresponding to the positions of the perforations, which circuits were traced hereinabove. The holding circuits for these relays as described extend from conductor 250, through the holding coils *b* of relays R42 and R43, and coil of relay R44, switch S33, and contacts P18 to conductor 251. Magnets MA5*u* and MA5*t* are again energized due to the closure of contacts R44*a*. Through the said contacts R42*a* and R43*b*, a number of timed impulses, corresponding in number to the sensed control data, are impressed upon the advancing magnets MA2*u* and MA2*t* of the second group of storing devices, by means of the circuits, from conductor 250 to magnets MA2*u* and MA2*t*, contacts 2 of the group CT of relays SR5*u* and SR5*t* respectively, contacts R43*b* and R42*a*, switch S18 and contacts 158 to conductor 251, thus entering the control number into the said relays, corresponding to the control number, sensed on the second card at the auxiliary sensing station. After sensing the said second card, the relays R42, R43, magnets MA5*u* and MA5*t* are deenergized, due to the opening of contacts P18. Immediately thereupon, arms SA5*u* and SA5*t* of relays SR5*u* and SR5*t* are advanced to the third contacts of the groups CT5*u* and CT5*t* to direct the impulses, initiated by contacts 158, to the advancing magnets MA3*u* and MA3*t* of a third group of storing devices, when the control number is sensed on the third card at the auxiliary sensing station.

It was mentioned, that during the sensing of the second card at the auxiliary station, the first card sensing operations are begun at the main sensing station. It will now be described, how the data sensed at the main station, which is the data to be reproduced upon the individual film frames, is stored, and thereafter effective to control the film recording operations. The first film frame recording is controlled directly from the card at the main station, and for all the remaining frames to be reproduced, the recording operations are controlled by the stored data.

Upon sensing the amount data perforations (or data to be reproduced) at the main station, the following circuits are completed through the sensing brushes 116: conductor 250 to contacts R21*b*, pick-up coils *a* of relays R36 and R37, conductors 192, brushes 116, conducting roller 117, contacts P15, parallel circuit arrangement comprising contacts R30*k* and R6*f*, contacts 57 to conductor 251, energizing the said relays. Cir-

cuits are then completed from conductor 250, contacts R21b, to holding coils b of relays R36 and R37, and contacts C12 to conductor 251, to maintain the said relays energized during the sensing operations at the main sensing station. Upon sensing the amount data perforations as described, two operations are effected simultaneously, (1) recording the sensed amount data upon the first film frame directly from the sensed record card, and (2) storing the data sensed into suitable storing devices such as relays SR8 and SR9. To effect entry of the data in the said storing devices, the impulses, initiated by the cam controlled contacts 162, are impressed upon the magnets MA8 and MA9, by the circuits from conductor 250, magnets MA8 and MA9, contacts R18f and R18h respectively, contacts R36a and R37a respectively, to contacts 162 and conductor 251, causing the said magnets to be energized a plurality of times, depending upon the time of closure of contacts R36a and R37a, thereby advancing the conducting arms SA8 and SA9 accordingly, to represent by their position the data sensed by the brushes 116.

The sensed data is reproduced upon the first film frame of the group directly from the sensed card, by means of the circuits extending from conductor 250 to contacts R21b, switch S26, individual light sources 175, conductors 194, contacts R31h and R31i (relay R31 is energized after sensing the first card which was set forth hereinabove), brushes 116, conducting roller 117, contacts P15, R30k, R6f and 57 to conductor 251, energizing the individual light sources at the differential times, the perforations on the card are sensed at the main station.

It was mentioned hereinabove, that upon energization of the film feed control magnets 209 the photographic film record 180 is fed, intermittently, to the recording station, in synchronism with the intermittent feeding of the record card to the card sensing station, so that at the particular timed intervals the light sources are energized, by means of the card sensing circuits, the light sensitive record is exposed to the light rays at such intervals to effect recording thereon in the form of control spots.

Each film frame reproduced is counted, and the circuit controlling this operation is as follows, which is completed each machine cycle, and effective to enter a digit into the data storing means SR4u until relay R30 is deenergized: conductor 250, magnet MA4u, contacts R30h, switch S13 and contacts F9 to conductor 251, energizing the said magnet, to cause advancement of the associated conducting arm SA4u one step, upon deenergization of the magnet, thus entering a digit into the said data storing means.

It is remembered, that upon completion of the sensing operations at the main station, card feeding operations are interrupted at the end of the machine cycle, due to energization of relay R30, and operation of the contacts R30a included in the card feed magnet control circuit, and that, upon completion of the said sensing operations at the main station, relay R31 is energized by means of the contacts C11 and contacts R30j. Upon energization of relay R31, the contacts R31h to R31k are opened, and contacts R31a to R31c are closed. Contacts R31a establish a holding circuit for relay R31, which is maintained until relay R30 is deenergized. Contacts R31b and R31c now connect the data storing devices SR8 and SR9, respectively, to the individual light sources 175 to reproduce an individual film frame, each cycle, in accordance with the data stored in the devices, until the number of frames reproduced correspond to the number indicated on the card, and stored in the relays SR1u and SR1t. The reproducing circuits are now as follows: conductor 250, contacts R21b, switch S26, light sources 175, conductors 195, contacts R31b and R31c, contacts R18k and R18m, conductor 240, conducting arms SA8 and SA9 respectively, contacts CT8 and CT9 respectively, conducting segments 60a of the emitter device 59a, brush 58a, switch S25, contacts F14, conductor 196 to contacts 57 and conductor 251, energizing the individual light sources 175, to record control spots on the film frame, at those particular times, when circuits are completed through the emitter device 59a, and data storage devices SR8 and SR9.

After a predetermined number of film frames have been reproduced, to correspond to the predetermined number sensed on the card from which the reproduced data was sensed, relay R25 is energized to wipe out the control data and amount data stored in relays SR1u, SR1t, SR8 and SR9, and condition automatically other circuits, so that the data can be reproduced from the next card, and reproduce as many film frames as indicated on the said card by the control data disposed thereon.

Assume, that the control data set up in relays SR1u and SR1t is equal to fifteen, indicating that fifteen film records or frames are to be reproduced, in accordance with the data stored in relays SR8 and SR9. When the tenth film frame is reproduced, the magnet MA4u is operated to advance the conducting arm SA4u, to close the contacts TC4u to enter one into the tens order relay SR4t, by the following circuit: conductor 250, magnet MA4t, contacts TC4u and conductor 251, energizing the magnet, which when deenergized (upon reset of relay SR4u), effects advancement of conducting arm SA4t to the contact 1 of the group of contacts CT4t, thereby representing the number ten. Closure of contacts TC4u also completes a circuit from conductor 250 to contacts C7, magnet MR4u, contacts R25c, and TC4u to conductor 251, energizing the said magnet to effect resetting of arm SA4u to the normal position, shown in Fig. 12c, to engage the first contact of the group CT4u, and to unlatch the contacts TC4u. The arm SA4u is now again advanced, step by step, for each film frame reproduced, until the said arm engages the contact 5 of the group, whereupon a circuit is completed as follows, near the end of the cycle: conductor 250, arm SA4t, contacts 1 of the groups CT4t and CT1t, arm SA1t, contact 1 of group CT7t, arms SA7t and SA7u, contact 1 of the group CT1u, arm SA1u, contacts 5 of groups CT1u and CT4u, arm SA4u, coil of relay R25, contacts R30g and contacts C6 to conductor 251, energizing the said relay for a brief period in the said cycle. Upon closure of the contacts F10, the reset magnets of relays SR4u and SR4t, SR8 and SR9 are energized by the following circuit: conductor 250 to contacts C7, magnet MR4u, contacts R25d and R25g, switches D5, S15 and contacts F10 to conductor 251, energizing the said magnet; conductor 250 to magnet MR4t, conductor 197, contacts R25g, switches D5, S15 and contacts F10 to conductor 251, energizing said magnet; conductor 250 to magnets MR8 and MR9, conductor 197, switch S22, contacts R25g, switches D5, S15 and contacts F10 to conductor 251, energizing said magnets; conductor 250 to magnet MR1u, con-

tact 1 of the group CT6*u*, arm SA6*u*, contacts R25*g*, switches D5, S15, contacts F10, to conductor 251, energizing said magnet; conductor 250 to magnet MR1*t*, contact 1 of group CT6*t*, arm SA6*t*, conductor 197, contacts R25*g*, switches D5, S15, contacts F10 to conductor 251, energizing said magnet. Energization of the said magnets causes the conducting arms of the relays SR4*u*, SR4*t*, SR8, SR9, SR1*u*, and SR1*t* to be returned to normal position to engage the first contacts of the respective groups of associated contacts, thus wiping out the data set up in the said relays. While the resetting of the said conducting arms is effected, a holding circuit for relay R25 is provided, extending from conductor 250 to contacts R25*b*, coil of the said relay, contacts R25*a* and C6 to conductor 251. Thus, relay R25 is maintained energized during the said resetting operations. In addition thereto, the following circuits are completed to energize the advance magnets of relays MA6*u*, MA6*t*, MA7*u* and MA7*t*: conductor 250, magnets MA6*u*, MA7*u*, MA6*t* and MA7*t*, common conductor 197, contacts R25*g*, switches D5, S15 and contacts F10 to conductor 251, energizing said magnets, which, when deenergized upon the opening of contacts R25*g*, cause the corresponding arms SA6*u*, SA7*u*, SA6*t* and SA7*t* to engage the second contacts of the associated groups of contacts, thus selecting the second group of control data storing devices, namely, relays SR2*u* and SR2*t*.

Near the end of the cycle, during which relay R25 is energized, relay R30 is deenergized, due to contacts C10 being opened at this time, to break the holding circuit for relay R30. Relay R30 remains deenergized less than one cycle until contacts C10 are again closed during the following cycle, however, during the timed interval relay R30 is deenergized, magnets 20 are energized, due to closure of contacts R30*a*, to cause the card feeding mechanism to be operated, during one cycle, to feed the cards, so that the second card is now fed past the main sensing station, and the third card is fed past the auxiliary sensing station.

The amount data on the said second card is sensed, by brushes 116, to energize relays R36 and R37 at different timed intervals in the sensing cycle, just as described hereinabove. The sensed data is reproduced on the film record, due to energization of the light sources 175, similarly as described hereinbefore, and it is remembered, that the sensed data is also entered in the storing relays SR8 and SR9. Further reproduction of the data, upon the film record, is then produced from the data set up in the said storing relays SR8 and SR9. Counting of the individual records on frames reproduced upon the film record is effected, exactly as described hereinabove, and when the number entered in the counting relays SR4*u* and SR4*t* corresponds to the control number entered in the second storing devices SR2*u* and SR2*t*, relay R25 is energized, to wipe out the data settings in the devices, just referred to, and effect selection of the next storage devices, in which is stored the control number disposed on the card which is to be sensed next at the main sensing station.

The operations of the machine for each card presented to the auxiliary sensing station, and later presented to the main sensing station, are exactly as set forth hereinabove, for this reason, it is believed that further description for the record card to film record reproduction operations is not necessary.

It should be mentioned that relays SR5*u* to SR7*u* and SR5*t* to SR7*t* are provided with individual contacts TC5*u* to TC7*u* and TC5*t* to TC7*t*, respectively, so that, when the third impulses are impressed upon the advance magnets of the said relays, the corresponding transfer contacts are closed to cause the associated reset magnets of the relays to be energized, thus resetting the conducting arms to the first contacts of the group, for the purposes set forth hereinabove.

Now, in order to effect checking operations for this type of run, the perforated cards are fed through the machine, in the same order as during the recording operations, just described, for producing the film record. After development of the film record produced, and proper positioning of it in the machine, so that the individual frames are sensed at the time the corresponding cards are sensed, the start key is depressed to effect conditioning of the machine as described. Reference should be made to Figs. 12*a* to 12*d* and 12*o* (arranged in the order named), the switches remaining in the same position, as during the film recording operations, with the exception of S28 which is set in the FC position, to effect continuous energization of the light sources 175. Upon conditioning the machine for continuous operation, the perforated record cards and recorded film records are fed in timed relationship past the related sensing stations. The control circuits employed for this type of operation are exactly the same, as those traced in detail in the first part of the instant section, therefore the operations controlled by the said circuits will be referred to generally, without repeating the exact tracings of the circuits. The additional control circuits employed will now be set forth.

During the machine conditioning cycles, the storage relays are reset to the normal positions, as shown in the figures, the operations of which have been described hereinabove, so that it is understood, that the class data sensed on the record cards, by the brushes 112 at the auxiliary station, are effective to control the operation of relays R42 and R43 at the differential times the said data is sensed, thereby effecting entry of the class data of the first card in the storage relays SR1*u* and SR1*t*, by means of the operated contacts R42*a* and R43*b*. As mentioned before, the class data of the second card is stored in the relays SR2*u* and SR2*t*, the class data of the third card in relays SR3*u* and SR3*t*, and the class data of the fourth card in relay SR1*u* and SR1*t*, etc. The amount data (or data to be compared) of the cards are sensed, by brushes 116 of the main sensing station, to control the operation of relays R36 and R37 to effect entry of this data in the storage relays 2R8 and 2R9, by means of the contacts R36*a* and R37*a*.

The first comparing operation is effected as follows: the brushes 116 also complete circuits through the coils *a* of the differentially wound relays R32 and R33 which extend from conductor 250 to contacts R21*b*, coils *a* of said relays, contacts R31*h* and R31*i*, brushes 116, conducting roller 117, contacts P15, contacts R30*k* and R6*f* to contacts 57 and conductor 251. Sensing of the amount data on the film record to be checked also causes the circuits to be established, from conductor 250 to contacts R21*b*, coils *b* of relays R32 and R33, contacts 262 and contacts 57 to conductor 251. Assuming, that the said coils *a* and *b* of relays R32 and R33 are energized, at the same differential times, the said relays remain un-

operated. Now, upon completion of the first sensing cycle of the amount data on the card, relays R30 and R31 are energized, interrupting further card feeding operations until relay R25 is energized, that is, until all the duplicated film frames have been checked, and compared with the data set up in the storage devices SR8 and SR9. In the present type of run, it is only necessary to use one group of the data storage relays SR8 to SR11, for this reason relay R18 is not necessary, and is disconnected from the circuits by means of switches D2 and D3.

Now, in order to check the duplicated film frames with the stored data, the following circuits are established, each cycle, until the number of film frames checked is equivalent to the number set up in the class data or control data storage relays: conductor 250 to contacts R21*b*, coils *a* of relays R32 and R33, contacts R31*b* and R31*c*, switches 29 and 30 respectively, conductors 240, storage relays SR8 and SR9, emitter 59*a*, switch S25 and contacts F14 to conductor 196, contacts 57 and conductor 251. Circuits are also established from conductor 250 to contacts R21*b*, coils *b* of relay R32 and R33, contacts 262 to contacts 57 and conductor 251. Therefore, it is seen, that as long as the described circuits are established, at the same timed intervals, the relays R32 and R33 remain deenergized to permit continuous operation of the machine. Upon disagreement of the compared data, the relays are operated to effect energization of relay R9, and interrupt the operations of the machine as described hereinabove.

As each film frame is checked, a digit is entered in the counting relays SR4*u* and SR4*t*, by means of cam operated contacts F9, which contacts are closed momentarily each cycle, until the number of film frames checked is equal to the number set up in corresponding class data storage relay. When the numbers entered in the said relays agree, relay R25 is energized, as described hereinabove, to effect resetting of the data storage relays to normal position, and cause deenergization of relays R30 and R31, thus permitting card feeding operations to be resumed (due to closure of contacts R30*a*) to feed the next card to the main sensing station, and resume comparing operations as just described.

F—Card recording with master film frame and checking operations.—Referring now to Figs. 12*a* to 12*d* and 12*p* (arranged in the order named), a description first of card recording operations including master film frame control operations will be given briefly, followed by a description of the checking operations for this type of run. Assume now, that the control switches S are set in the FC position, that switches D1 to D10 are set in the A position, and that the start key is depressed to close contacts SK2 long enough to condition the machine for automatic operation. In view of the detailed description given in section E, and the sections preceding it, the following is believed to be sufficient for understanding the instant recording and checking operations.

The control numbers disposed on the film records, (indicating the number of cards which are to be reproduced in accordance with the data disposed on the film records), are sensed at the auxiliary sensing station to control the operation of the relays R266, thereby controlling the operation of the relays R42 and R43 at the differential times the control spots are sensed. Relays SR5*u* and SR5*t* are then controlled to select successively the control data storing devices, namely, SR1*u*, SR1*t* representing one group of data storing devices, relays SR2*u* and SR2*t* representing the second group, and relays SR3*u* and SR3*t* representing the third group. Upon selection of the control data storing devices, the control data sensed on the film records is then entered therein under control of the contacts R42*a*, R43*b* and contacts 160. After entering the sensed control data in the selected storing devices, the data to be reproduced is sensed, at the main sensing station, to control the operation of relays 261, which in turn control the operation of relays R36 and R37. Operation of relays R36 and R37, at the differential times the control spots are sensed, controls the entry of the data to be reproduced in the storage devices represented by relays SR8 and SR9. Operations of the relays 261 also are effective to control the timed operations of the punch magnets 66, thereby controlling the times at which the associated punch plungers are actuated to perforate the blank cards. Upon reproduction of the first card of the group of cards to be reproduced, relay R31 is operated, to render the data storage devices SR8 and SR9 to be effective, to control the punch magnets 66 each cycle in accordance with the data stored therein. For each card reproduced an entry of one is made in the counting relays SR4*u* and SR4*t*. When the number, entered in the last mentioned relays, corresponds to the number, set up in one of the selected control data storing devices (SR1*u* and SR1*t*; SR2*u* and SR2*t*; SR3*u* and SR3*t*), relay R25 is energized to control the resetting operations of the mentioned data storage devices, thus wiping out the data stored therein. The resetting operations, it is remembered, are controlled by contacts R25*d*, R25*g*, and contacts P7. Upon operation of relay R25, relays SA6*u*, SA6*t*, SA7*u* and SA7*t* are operated to select the next control data storage device. Operation of relay R25 also causes the relay R30 to be deenergized, which in turn, renders the film feeding mechanism operative for a machine cycle to present the next film record to the auxiliary and main sensing stations, to repeat the operations just set forth in accordance with data disposed thereon.

Provision is made in the machine, whereby the checking operations for this type of run can be effected during the card reproducing operations, but one cycle later than the reproducing operations. In view of the detailed description included in the instant section, and the detailed description hereinabove, of the control circuits employed during checking operations, the following description is deemed sufficient.

After entry of the control number, sensed at the auxiliary film sensing station, in one of the groups of data storage devices, for example, SR1*u* and SR1*t*, the amount data of the film record is sensed to control the punch magnets 66, and the entry of the data in the amount data storing relays, which relays after the reproduction of the first card, control the energization of the said punch magnets. As mentioned hereinabove, after sensing the master film frame, relay 31 is energized to disconnect the punch magnets 66 from the contacts 262 of relays 261. During the read out operations, which occur a cycle after recording operations, the impulses, corresponding to the data set up in the amount

storing relays, for example, SR8 and SR9, are impressed upon contacts R31*b* and R31*c*, and R6*g* and R6*h* (relays R6, R18 and R31 are energized during this cycle), to effect punching operations, and comparing operations. The timed impulses impressed upon contacts R31*b* and R31*c* are directed to the punch magnets 66, by the plug connections shown, to energize the magnets in accordance with the stored amount data. The impulses impressed upon contacts R6*g* and R6*h* are effective to energize the coils *b* of the comparing relays R32 and R33. The coils *a* of said relays are energized by the impulses initiated by the main sensing brushes 116 which sense the data on the card punched in the previous cycle. Now, as long as the compared data is in agreement, relays R32 and R33 remain inoperative, however, upon disagreement of the data compared, the relays are operated to effect energization of relay R9 to interrupt the automatic operations of the machine, in a manner now understood.

Assuming that the compared data is in agreement, the reproduction of the cards in accordance with the stored data continues, until the number entered in the counting relays SR4*u* and SR4*t* is equal to the control number or class data, set up in the selected group of storing relays, for example, SR1*u* and SR1*t*. As mentioned before, when these two settings agree, relay R25 is energized to control the resetting of the mentioned storage relays, as described hereinabove.

It should be mentioned, that upon energization of relay R25, the associated contacts 25*e* are closed to effect energization of relay R28, when contacts P7 are closed near the end of the cycle. The holding circuit for relay R28 is established through contacts R28*b* and P10. Energization of relay R28 causes relay R15 to pick up, and be locked through the contacts R15*a* and C5. The resetting circuits, described hereinabove, are then established through the contacts R15*b*. In this particular run, the resetting operations necessarily are delayed for one cycle, and this is effected by the operations of relays R28 and R15 just described.

Relay R18 is operated to control the selection of the groups of the amount data storing relays, and also to control the reading out operations, by means of contacts R18*j*, R18*k*, R18*l* and R18*m*, so that the timed impulses initiated in accordance with the stored data are directed to the punch magnets and comparing relays.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a record reproducing machine controlled by pattern records containing data to be reproduced, means for sensing the data on the pattern records, means under control of said sensing means for reproducing record copies of the patterns sensed, and other means under control of the said sensing means for comparing the data reproduced on the record copies with the data sensed on the said pattern records.

2. In a record reproducing machine controlled by pattern records containing data to be reproduced, means for sensing the data on a pattern record, means under control of said sensing means for reproducing a record copy of the pattern, other means under control of the sensing means for storing the data sensed on the said pattern record, and means for comparing the stored data and data reproduced on the record copy.

3. In a record reproducing machine controlled by pattern records containing data to be reproduced, means for sensing the data on a pattern record, means under control of said sensing means for reproducing a record copy of the pattern, other means under control of the sensing means for storing the data sensed on the said pattern record, additional means for sensing the data reproduced on the record copy, and means under control of the storing means and said additional sensing means for determining the relationship of the stored data and reproduced data.

4. The invention set forth in claim 3 in which means are provided and controlled by the said determining means for interrupting the reproducing operations whenever the stored and reproduced data are in disagreement.

5. In a record reproducing machine controlled by pattern records containing data to be reproduced, means for sensing the data on a pattern record, means under control of said sensing means for reproducing a record copy of the pattern, means for conditioning the machine to effect continuous and automatic reproducing of record copies from the pattern records, other means under control of the sensing means for storing the data sensed on the said pattern record, additional means for sensing the data reproduced on the record copy, means under control of the storing means and said additional sensing means for determining the relationship of the stored data and reproduced data, and means controlled by the determining means for interrupting the continuous and automatic operations of the machine whenever the said stored and reproduced data bear a predetermined relationship.

6. The invention set forth in claim 5 in which indicating means are provided and controlled by the determining means to indicate the interruption of the continuous and automatic operations of the machine.

7. In a record reproducing machine controlled by pattern records containing data to be reproduced and a control number for determining the number of record copies reproduced, means for sensing the data and control number on a pattern record, means under control of said sensing means for reproducing record copies of the pattern, other means under control of said sensing means for controlling the number of record copies produced, and means for comparing the data reproduced on the record copies with the data sensed on the corresponding pattern records including means for comparing the number of record copies produced with the control numbers sensed on the pattern records.

8. In a data reproducing machine controlled by individual records containing data designations to be reproduced on blank records, a first and second group of record sensing and related recording means for sensing and recording on the records, respectively, means for feeding blank or recorded records past the sensing and recording means of the first group, means for feeding

blank or recorded records past the sensing and recording means of the second group, means for operating the said feeding means in synchronism so that the records are presented to the respective sensing and recording means in a predetermined time relationship, means for alternately selecting and rendering effective the sensing means of the said groups for alternately controlling the related recording means of the said groups thereby controlling the selected recording means to reproduce the data upon the blank record presented thereto, in accordance with the data sensed upon the recorded record presented to the selected sensing means, and means for comparing the data recorded upon the said blank records with the sensed data to verify the said data recorded upon the blank records.

9. The invention set forth in claim 8 in which the said selected recording means comprises record card perforating means.

10. In a data reproducing machine controlled by individual records containing data designations to be reproduced on blank records, a first and second group of record sensing and related recording means for sensing and recording on the records, respectively, means for feeding blank or recorded records past the sensing and recording means of the first group, means for feeding blank or recorded records past the sensing and recording means of the second group, means for operating the said feeding means in synchronism so that the records are presented to the respective sensing and recording means in a predetermined time relationship, common control circuits, means for alternately connecting the sensing means of the said groups and the related recording means of the said groups to the common control circuits, means controlled by the circuits whereby the recorded records sensed by the connected sensing means are effective to control the connected recording means for recording the data sensed upon the blank records presented thereto, and means for verifying the data recorded upon the last mentioned records thereby determining that the data recorded upon said blank records is in agreement with the said sensed data.

11. The invention set forth in claim 10 in which the said connected recording means comprises record card perforating means.

12. A machine of the character described comprising means for feeding record cards provided with data designations to a sensing station, means provided at said station for sensing the said data designations, means for feeding unrecorded photographic areas to a recording station, photographic recording means provided at said recording station, means for operating the said feeding means in synchronism so that the cards and photographic areas are presented to the respective stations in a predetermined time relationship, means controlled by the sensing means for controlling the said recording means to reproduce the data upon the photographic areas in accordance with the data sensed upon the record cards, and means for verifying the data recorded upon the photographic areas to determine that the data recorded upon said areas is in agreement with the sensed data.

13. A machine of the character described comprising means for feeding record cards having data designations to a sensing station and means for feeding photographic records having data designations to a sensing station, means for operating the said feeding means in synchronism so that the records are presented to the respective stations in a predetermined time relationship, individual means provided at said stations for sensing the data designations on the records presented thereto, means controlled by the said sensing means for determining whether the data sensed on the records is in agreement, and means controlled by the last mentioned means for interrupting the normal feeding operations of the said feeding means upon disagreement of the said sensed data.

14. The invention set forth in claim 13 in which the said interrupting means comprises electromagnetically controlled means.

15. A machine of the character described comprising means for feeding record cards having data designations to a sensing station, means for feeding photographic records having data designations to a sensing station, means for operating the said feeding means in synchronism so that the records are presented to the respective stations in a predetermined time relationship, individual means provided at said stations for sensing the data designations on the records presented thereto, means controlled by the sensing means for comparing the data sensed on the records to determine whether the said data sensed is in agreement, and means controlled by the comparing means for maintaining the said feeding means operative as long as the compared data is in agreement including means for interrupting the normal feeding operations of the said feeding means upon disagreement of the compared data.

16. A machine of the character described comprising means for feeding blank cards to a recording station, card recording means thereat, means for feeding photographic records provided with data designations to a sensing station, means at the second mentioned station for sensing the data designations disposed on the records, means for operating the said feeding means in synchronism so that the cards and records are presented to the respective stations in a predetermined time relationship, means controlled by the sensing means for controlling the said recording means to reproduce the data upon the blank cards presented thereto in accordance with the data sensed upon the said photographic records, and means for verifying the data recorded upon the said cards to determine that the data recorded upon said cards is in agreement with the sensed data.

17. The invention set forth in claim 16 in which the card recording means comprises perforating means.

18. A machine of the character described comprising means for feeding blank cards to a recording station, card recording means provided at said station, means for feeding photographic records provided with data designations to a sensing station, means at the sensing station for sensing the data designations disposed on the records, means for operating the said feeding means in synchronism so that the cards and records are presented to the respective stations in a predetermined time relationship, means controlled by the sensing means for controlling the recording means to reproduce the data upon the blank cards presented thereto in accordance with the data sensed upon the said photographic records, means for comparing the data recorded upon the cards with the data sensed on the said records, and means for interrupting the recording and comparing operations when the said compared data is in disagreement.

19. A machine of the character described comprising means for feeding blank cards to a recording station, card recording means provided at said station, means for feeding photographic records provided with data designations to a sensing station, means at the sensing station for sensing the data designations disposed on the said records, means for operating the said feeding means in synchronism so that the cards and records are presented to the respective stations in a predetermined time relationship, means controlled by the sensing means for controlling the recording means to reproduce the data upon the blank cards presented thereto in accordance with the data sensed upon the said photographic records, means for reproducing a predetermined number of cards in accordance with the data disposed on a single photographic record, and means for verifying the data recorded upon the said cards to determine that the data recorded upon said cards is in agreement with the sensed data including means for indicating the number of cards reproduced in accordance with the data disposed on a single record.

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